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by

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Date 19 November, 1984

Abstract

Modeling prehistoric, hunter-gatherer subsistence activities is an important research topic in contemporary archaeology. Many of the models for examining how people formerly used food resources have not been adequately tested. Part of this problem is because such data are either not available for the prehistoric context, or because they have simply not been collected. This dilemma becomes obvious by examining the divergent directions being pursued in method and theory in zooarchaeology.

Binford's (1978) approach to the study of prehistoric, hunter-gatherer subsistence activities does articulate method and theory. He devises a set of indices for quantifying the food value of body parts of wild animals. The indices are used to model decision-making regarding the rational use of caribou and sheep carcass parts by the Nunamiut.

The approach designed by Binford is adopted in this study to examine how muskoxen were exploited by the Copper Inuit who lived on northern Banks Island during the 19th century. A set of food value indices are developed for muskox anatomical parts, and they are employed to predict how the carcasses of these animals were exploited at three archaeological sites.

Ethnographic, wildlife and archaeological information enable the reconstruction of how muskoxen were procured. Models of food use based on the indices show that muskox carcasses were differentially treated on and among the Copper Inuit sites with respect to their meat, marrow and grease food value. Differences in animal procurement and site seasonality influenced how animal resources were used.

It is argued that the specific models generated in this study do not take into account the social value of food products. This may have been an especially important factor in Copper Inuit subsistence practices. Additionally, data are provided which suggest that some form of animal management may have been practiced. This issue and others are discussed in the contexts of Stefansson's (1921) assertion that the Copper Inuit were responsible for the extirpation of muskoxen on Banks Island during the 19th century.

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Few research projects are initiated and completed without financial support, the sharing of information and ideas with other scholars, and a variety of valuable contributions made by colleagues and friends. This project significantly benefitted from assistance made in all of the above categories.

The Boreal Institute for Northern Studies (University of Alberta) generously provided two years of financial support. The administration of the Boreal grant by Ms. Anita Moore greatly enhanced my opportunities for conducting research. Logistical field support was awarded by the Polar Continental Shelf Project (Dept. of Energy, Mines and Resources, Ottawa). The friendly and efficient staff at Resolute Bay, N.W.T. made my stays there memorable while en route to and from the field. A small grant from the Society for Sigma Xi also aided my field research in 1982. The Department of Anthropology (University of Alberta) offered an atmosphere conducive to student research by alloting me adequate space and computer funds to complete the project. Data analysis and write-up would have been greatly delayed except for the timely award of a University Dissertation Fellowship.

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Table of Contents

Chapter Page

I. On Method and Theory in Zooarchaeology 1

Introduction 1

Binford's research on Nunamiut subsistence ..5

The present study 10

II. The Copper Inuit: Early Twentieth Century Subsistence Practices 15

Introduction 15

The Copper Inuit and Banks Island 16

Copper Inuit seasonal round 20

Food resource selection 22

Caribou utilization 23

Comparison with Nunamiut caribou use 25

III. Muskox Biology and Behavior Relevant to Human Exploitation 27

Introduction 27

Physical characteristics 29

Herd characteristics 32

Muskox productivity 40

Muskox anti-predator behaviors 50

Summary 54

IV. Food Utility Indices and Other Quantitative Measures 57

Introduction 57

Food utility indices 58

Construction of the Maturity Index (MATI) ..80

Discussion of the minimum number of individuals (MNI) estimation method 87

V. Data Collection: The Copper Inuit Sites and Methodological Considerations 92

Introduction 92

Site selection 92

Site descriptions 101

Methods 118

VI. Muskox Procurement and Use: Site Analyses 129

Introduction 129

Haogak site analyses 142

Nasogaluak site analyses 170

Kuptana site analyses 191

Discussion 210

VII. Bones and Beyond 212

Introduction 212

Faunal patterning: cultural vs. functional behavior 212

Resource management and muskox extinction on Banks Island 215

Directions for Future Zooarchaeological Research 220

Summary 222

Bibliography 224

List of Tables

Table

3.1 Weights of Male and Female Wild Muskoxen..............31

3.2 Gross Weight of Muskox Body Parts....................33

3.3 1982 Observations of Muskoxen, Thomsen River, Banks Island, N.W.T...36

3.4 1982 Observations of Muskoxen, Coastal Survey, Banks Island, N.W.T...37

3.5 Population Estimates of Banks Island Muskoxen for the Period 1911-1982...................................48

4.1 Comparative Body Proportions for Muskox...............62

4.2 Gross Weight of Anatomical Part/Total Weight of Limb..64

4.3 Variables Required for Constructing a Muskox Meat Utility Index (Appendicular Parts)...................66

4.4 Appendicular Dry Bone Weights for Selected Artiodactyl Skeletons (element dry weight/total limb dry weight)...68

4.5 Approximated Muskox Meat Utility Index................70

4.6 Construction of Approximated Muskox Marrow Index......74

4.7 Construction of Approximated Muskox Bone Grease Index.78

4.8 Approximated Muskox White and Yellow Grease Indices...78

6.1 Construction of Approximated Muskox General Utility Models...136

6.2 Minimum Number of Individual Counts for the Haogak

Muskox Assemblage....................................145

6.3 Calculation of the Maturity Index (MATI) for the Haogak Site....................................148

6.4 Food Utility Models for Examining the Archaeological Context....................................152

6.5 Summary characteristics of Haogak Activity Areas.....158

6.6 Anatomical Part Counts from Haogak Activity Areas....159

6.7 Minimum Number of Individuals Count for the Nasogaluak Muskox Assemblage........................172

6.8 Calculation of the Maturity Index (MATI) for the Nasogaluak Site....................................174

6.9 Summary characteristics of Nasogaluak Activity Areas.180

6.10 Anatomical Part Counts from Nasogaluak Activity Areas....................................182

6.11 Minimum Number of Individuals Count for the mapped portion of the Kuptana Muskox Assemblage............194

6.12 Calculation of the Maturity Index (MATI) for the Kuptana Site....................................197

6.13 Summary characteristics of Kuptana Activity Areas...202

6.14 Anatomical Part Counts from Kuptana Activity Areas..206

List of Figures

Figure

1.1 Banks Island and place names mentioned in text........11

5.1 Location of Haogak (PhPo-3), Nasogaluak (PgPw-3) and Kuptana (PjRa-18) Copper Inuit archaeological sites...93

5.2 Location of features and mapped area on the Haogak site (PhPo-3)...104

5.3 Locations of features and mapped area on the Nasogaluak site (PhPw-3).................................110

5.4 Kill-site of two bull muskoxen located about .5 km northeast of the Nasogaluak site (PgPw-3)...........112

5.5 Location of mapped areas on the Kuptana site (PjRa-18)..116

6.1 Relationship between weighted and averaged muskox general utility models 139

6.2 Distribution of muskox vertebra on the Haogak site...147

6.3 Relationship between the archaeological muskox general utility model and the %MNI from the Haogak muskox assemblage.......................................153

6.4 Relationship between the grease inverse model and the %MNI from the Haogak muskox assemblage...........155

6.5 Bone concentrations and stone features on the Haogak site..157

6.6 Relationship between the meat+marrow model and the %MNI from Haogak activity area 8....................166

6.7 Relationship between the archaeological muskox general utility model and the %MNI from the Nasogaluak muskox assemblage.........................177

6.8 Distribution of bone concentrations and stone features on the Nasogaluak site.......................179

6.9 Relationship between the marrow+grease model and the %MNI from Nasogaluak activity area 4.................186

6.10 Relationship between the archaeological muskox general utility model and the %MNI from the Kuptana muskox assemblage...................................199

6.11 Distribution of bone concentrations and stone features on the Kuptana site.........................201

6.12 Relationship between the marrow+grease model and the %MNI from Kuptana activity area 1................204

List of Photographic Plates

5.1 The Haogak site (PhPo-3) facing Prince of Wales Strait (northeast)....................................102

5.2 Muskox skeletal parts on the Haogak site (PhPo-3)....106

5.3 The Nasogaluak site (PgPw-3) facing south............108

5.4 The Kuptana site (PjRa-18) looking upriver (south)...114

5.5 The tripod system used for photo-mapping the sites...120

5.6 Photograph of Haogak grid square (162/044)..........122

I. On Method and Theory in Zooarchaeology

Introduction

Contemporary efforts to model hunter-gatherer subsistence patterns have borrowed heavily from theory developed outside of anthropology (see Jochim 1976; Perlman 1976; Reidhead 1976; Keene 1981; Winterhalder and Smith 1981). One example among many which illustrates this situation is Keene's (1981) optimal foraging model. He uses it to predict subsistence patterns among late Archaic hunter-gatherers who inhabited southern Michigan around 4,000-1,000 B.C. Optimal foraging theory is the basis for his model which originated in ecology. The method Keene relies on is linear programming (from economics) to construct models of subsistence strategies employed by Archaic people.

Keene's study is one of many recent attempts to use innovative approaches for studying past human decision-making. A difficulty with it, which is symptomatic of many other studies, is that input variables for modeling expectations of prehistoric subsistence patterns cannot be precisely measured with existing information. The variables incorporated into Keene's (1981:24-39) model include: 1) acquisition cost of resource, 2) resource distributional characteristics, 3) net productivity, 4) total food yield, 5) resource utility, and 6) seasonal fluctuations in biomass.

Paleoenvironmental data are too general for quantifying the six variables. Therefore, Keene depends on contemporary and historic information which in itself is often of insufficient detail. Additionally, the archaeological data used by Keene (1981) to corroborate predictions of his model are ambiguous, as is the case with archaeological tests of many of the intellectually intriguing hunter-gatherer subsistence models appearing in the current literature. As Styles (1984:435) states in her succinct review of Keene's study:

> Although Keene attempts to derive expectations of how his optimal foraging strategy would be reflected in the archaeological record, the archaeological evaluation of the model is a disappointment. The sites suffer from problems of multicomponency and abominable preservation. As one Michigan archaeologist put it, the excavated data are so equivocal that they can't be refuted. We are told that it is precisely in such a situation that the model can provide insight, ie., because the archaeological data base is inadequate. This is true only if we take the model as a given. Unfortunately, we are left with no way to evaluate the appropriateness of this provocative optimal foraging model to Late Archaic hunter-gatherers in the Saginaw Valley.

A relevant observation is that North American prehistoric sites in general are frequently plagued by the kinds of problems described for Michigan sites. Beginning in the late 1960s, studies of natural processes (for example, Behrensmeyer and Hill 1980; Binford 1981; Binford and Bertram 1977; Haynes 1982; Morlan 1981; and Voorhies 1969) have resulted in important contributions to understanding how the archaeological faunal record can be transformed.

These studies are exemplary of a whole new generation of research directed at relating patterning in osteological remains to process, or as Binford (1981) says, "discovering the bear who made the footprint."

Actualistic studies, as such investigations are commonly labelled, have multiplied in number at an incredible rate, but without much articulation with theoretical perspectives in current anthropology regarding hunter-gatherer subsistence patterns. The most important contribution made by this kind of research is the documentation of varied and patterned effects which non-human agents have imposed on the archaeological record.

Cultural transformations of subsistence resources into archaeologically visible residue have also been investigated with ethnoarchaeological observations. Research among the !Kung (Yellen 1977), Australian aborigines (Gould 1978, 1980) and northern hunter-gatherers (Binford 1978; Janes 1983) has offered considerable descriptive data on how contemporary peoples procure and utilize wild animal resources. These studies have not always been guided by theory, or directed at model building and testing. This situation attests to the lack of interaction between those individuals studying cultural and natural site processes which create and transform the archaeological record, and those researchers focusing their attention on higher level abstractions about human behavior. An exception to this generalization is Binford's (1978) work among the Nunamiut which is discussed below.

Due to the inadequacy of data for testing recent models of hunter-gatherer subsistence, many of the methodological pursuits of contemporary zooarchaeological research are out-dated. Appropriate information is not being collected. For instance, with respect to zooarchaeology, few investigations have been conducted to obtain data on the food value (however it is defined) of wildlife species. The discipline continues to focus on generalized descriptions of wildlife behavior and biology (see Will 1982) which have limited demonstrable relevance for understanding hunter-gatherer animal exploitation, and on developing methods for identifying and quantifying bone fragments.

Some models will inevitably require information for testing which is impossible to obtain, even in the most ideal archaeological situations. This does not imply that the models and their underlying theoretical perspectives are less anthropologically interesting than others. It does mean, however, that these models cannot be satisfactorily tested with archaeologically derived data, and that attempts to do so perhaps detract from their overall merits. This type of research contributes little to the development of middle-range theory. The reason, according to Merton (1968:38) is that, "...middle-range theory involves abstractions, of course, but they are close enough to observed data to be incorporated in propositions that permit empirical testing".

Binford's research on Nunamiut subsistence

Lewis Binford's (1978) study, **Nunamiut Ethnoarchaeology**, perhaps more than any other, offers challenges to the manner in which zooarchaeological research is being conducted in terms of the kinds of questions being asked, the analytical methods being used, and the type of data being collected. The implied theoretical orientation is based on the application of maximization theory to predict hunter-gatherer subsistence behavior. This is clear from Binford's use of such terms as maximizing, rational choice and decision-making (1978:19 and passim). Much of the remainder of this chapter will focus on Binford's (1978) contribution, since the present investigation relies heavily on it in the analysis to follow.

Binford conducted ethnoarchaeology among the Nunamiut of the central Brooks Range, Alaska, during the late 1960s and early 1970s. He lived with the people in Anaktuvuk Pass specifically to record their strategies of caribou (*Rangifer tarandus*) and mountain sheep (*Ovis dalli*) procurement, processing and consumption. Binford states that one reason he selected the Nunamiut for field study was because they were hunters who essentially depended on a single species, caribou, for more than 80% of their subsistence needs. He (1978:12-13) therefore argued that:

> If there was any place in the world where I could learn about the problems presented by a strong dependence on hunted food, how these problems were solved, and how such solutions are manifest archaeologically in faunal remains, it would be with the Nunamiut.

Maximization of food resource use appears to be Binford's research orientation, even though he does not fully develop the argument himself. It is defined as "rationalizing calculation" or the human behavior associated with the allocation of scarce resources in a rational manner (Burling 1962:813). This theoretical perspective provides a framework for Binford's behavioral analysis of people who employ multi-dimensional decisions in the exploitation of animal food resources. The analytical methods developed by Binford to examine how accurately Nunamiut subsistence practices can be predicted are archaeologically testable, and provide an "objective reference dimension against which to view manifest decision making" (Binford 1978:19).

A potential problem with the application of a method based upon maximization is cogently addressed by Cancian (1968:230):

> The use of maximization as a scientific strategy involves seeking out norms or motives (or whatever the investigator sees as the impetus of behavior) and attempting to rank order them so as to see the behavior as the (conscious or unconscious) maximization of these things. They become the ends being maximized. When using maximization as a scientific strategy, the investigator knows that his analysis is complete when he has stated the norms, motives, etc. and the conditions (means and their limits, the scarce factors) such that every act may be seen as a predictable maximization of the ends. If he cannot see the act as maximization, he immediately assumes that his statements of norms, motives, etc. and conditions are not yet correct and seeks to "balance the equation" so that it will work.

This criticism of maximization theory is appropriate in those cases where 1) no clear statement exists concerning what variables are maximized, and 2) specific properties of those variables are not defined and objectively measured. Cancian (1968:232) continues on to argue that the use of this perspective as a scientific strategy can even be productive in situations where maximization as a norm is not present. This is possible only in circumstances where the above two preconditions are satisfied, however,

Binford (1978) does provide an explicit statement about the variables (food value) being maximized, and he objectively quantifies them. The variables consist of animal foods: meat, marrow and grease, which are quantified in terms of their availability and quality in the anatomical parts of caribou and sheep. Indices (to be considered in detail in Chapter Four) are constructed to measure the relative value of each food. They are variously combined to model specific situations encountered by the Nunamiut. The situations, such as animal kill-sites or locations of meat drying and caching during the summer, provide the contexts in which maximization models are tested against the actual use of food resources by the Inuit.

There are historical precedents for Binford's research. White's (1952; 1953a and b; 1954) zooarchaeological contributions which included the first formulation of the MNI (minimum number of individuals) estimation procedure, and his use of carcass anatomical part counts (based on bone frequencies) to interpret butchering techniques are probably the earliest precursors. Lorrain's (1968) analysis of bison bones from Bonfire Shelter, Val Verde County, Texas also incorporated the notion of using anatomical part counts to document temporal and spatial variation in prehistoric bison butchery. None of the earlier scholarly efforts, however, compared data against a set of objectively defined and quantified food value scales. Therefore, explanations as to why certain bone elements or bone element portions occurred regularly in archaeological sites were dependent upon speculation or ethnographic analogy.

The significant contribution made by Binford was to provide a method for assigning food value to bones and bone portions so that models of resource use can be compared with data derived from archaeological faunal assemblages from various cultural contexts. He accomplished this task through an investigation of bone assemblages in the context of an on-going cultural system so that material manifestations attributable to specific behaviors could be carefully documented. The "bear" and its "footprint" were observed in order to formulate a modeling approach which possesses considerable potential for zooarchaeolgical research.

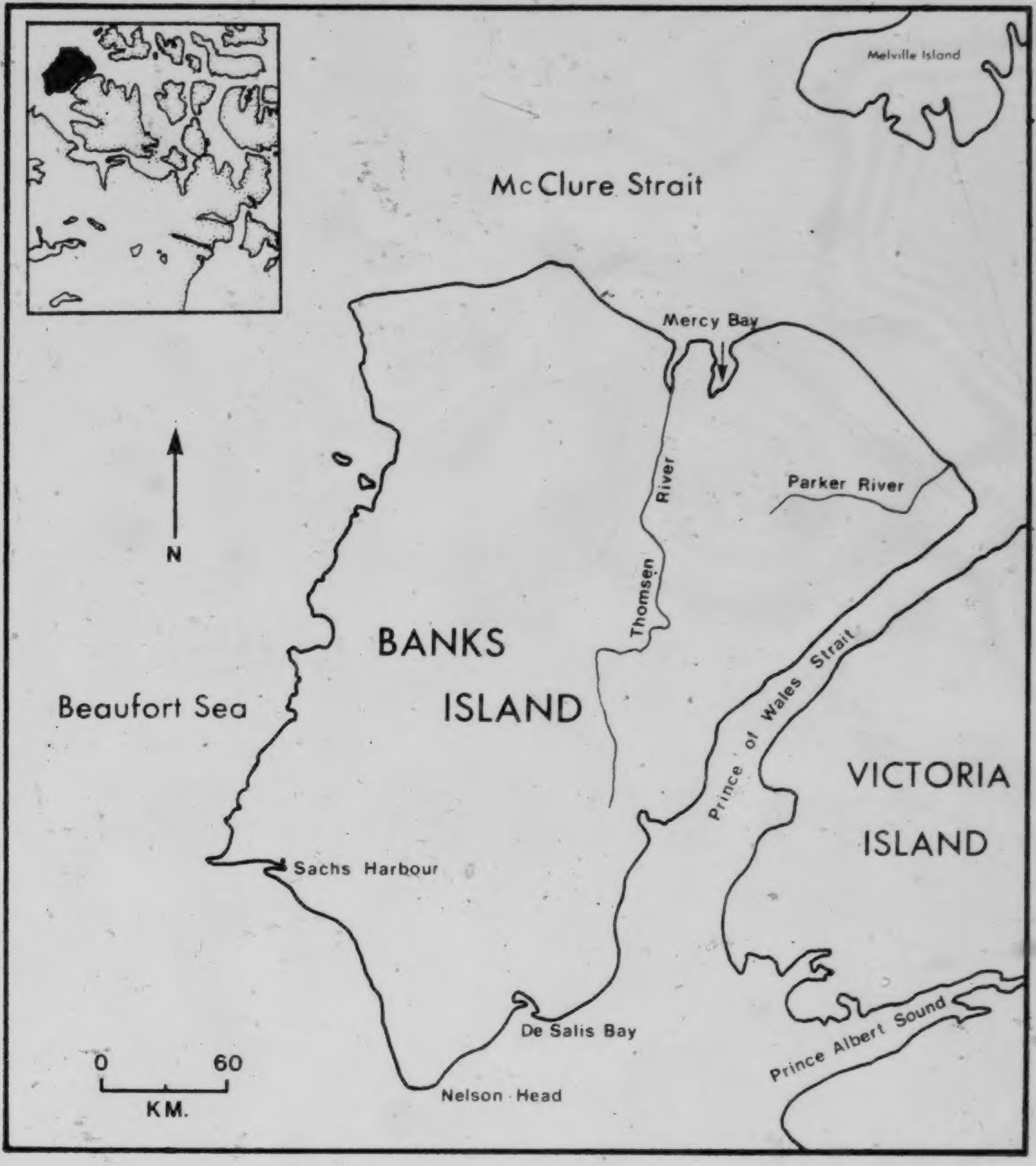
Although Binford's study is innovative in demonstrating how method and theory in zooarchaeology can be articulated, it is not without fault. Its perspective is rather narrowly defined in that animal resources are regarded strictly in terms of their food value. The possible social value placed on food by the Nunamiut regardless of its quality or quantity are not considered. While viewing the use of animal carcasses strictly in terms of food value may be appropriate for Binford's study of contemporary Nunamiut subsistence, it is probably too limited for a holistic examination of animal use in the past. For example, the importance of sinew, and the requirements of other animal products for the manufacture of tools is neglected in the construction of his models. Binford's approach is very materialistic in its perspective, and is symptomatic of the difficulty archaeologists have in modeling the social value of animals or animal products in a testable fashion. His methods for constructing food value indices are also subject to questioning, and are considered in detail in Chapter Four.

There have been few studies to follow up on Binford's original work published in 1978. One example is Speth's (1983) contribution to the zooarcheological literature entitled **Bison Kills and Bone Counts: Decision Making by Ancient Hunters**. It concerns the use of bison by late prehistoric hunters on the southern Plains. Another investigation (Gronnow et al. 1983) involves the examination of caribou exploitation by prehistoric Inuit in West Greenland. Contributions such as these are pointing out the direction of future zooarchaeological endeavors, as well as providing a standard against which other studies can be compared.

The present study

Binford's approach has enormous potential for those researchers advocating the development and testing of middle range theory (see Raab and Goodyear 1984), because it provides a rigorous method for linking human behavior with patterning in the faunal record. In addition, its strength lies in the logic of how to investigate a zooarchaeological problem. The method is employed in this study to investigate 19th century Copper Inuit procurement and use of muskoxen on Banks Island, N.W.T.

The successful application of Binford's approach to a set of archaeologically derived data partly depends upon two prerequisites. The first is that the stratigraphic context of the osteological remains should be unambiguously delineated. Faunal assemblages which were deposited over brief time periods are best for analysis. Archaeological sites from which data were obtained for this study meet this criterion. In 1854, the H.M.S. Investigator, a British exploration vessel and part of the Royal Naval effort to search for Sir John Franklin, was abandoned in Mercy Bay at the north end of Banks Island (Osborne 1969) (refer to Figure 1.1). During the next 40 years, Copper Inuit from neighboring Victoria Island visited Mercy Bay to collect exotic materials, such as metal, which were left in a cache deposited on shore by the Investigator's crew (Hickey 1979). It is not known whether Inuit made trips annually; however, sites associated with this 19th century occupation are well


Melville Island
McClure Strait
Mercy Bay
Parker River
Thomsen River
N
BANKS
ISLAND
Beaufort Sea
Prince of Wales Strait
VICTORIA
ISLAND
Sachs Harbour
De Salis Bay
Prince Albert Sound
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Nelson Head

Figure 1.1 Banks Island and place names mentioned in text.

defined temporally and, with respect to archaeologically divisible time units, were used only briefly. Further description and discussion of the Banks Island Copper Inuit occupation and the archaeological sites attributed to it, are found in Chapters Two and Five.

A second prerequisite is that well preserved faunal materials exist for study. Additionally, the taphonomic factors which may have affected them since entering the archaeological record should be elucidated. It is sufficient to note here that the cold Arctic environment, recent date of the sites, and minimal amount of site disturbances recognized in the field, make the archaeological remains amenable for using Binford's approach. Preservation and taphonomy of zooarchaeological materials recorded on the Copper Inuit sites are described in Chapter Five.

Two other factors enhance the appropriateness of employing Binford's method in the present investigation. One is that historical information on the Copper Inuit has been collected. The western Copper Inuit were one of the last northern peoples to undergo extensive contact with Euro-Canadian society. The works of Jenness (1922), and Stefansson (1913; 1921) provide interesting insights into how they lived before much direct interaction with the Western World had taken place. A general overview of the west-central Arctic people, with regard to their subsistence practices early in the 20th century, is presented in Chapter Two.

Second, during the late prehistoric occupation of northern Banks Island by the Inuit, the only abundant food resource was the muskox (*Ovibos moschatus*). The bones of this northern ungulate often constitute more than 85% of the faunal remains found in the Copper Inuit sites. The presence of numerous muskox remains has been used to support the contention that the Inuit extirpated the animals (for example, see Stefansson 1921; Vincent and Gunn 1981). Because this species was the focus of Copper Inuit subsistence activities, its biology and behavior are the subjects of discussion in Chapter Three.

Utility indices for measuring the food value of muskox anatomical parts are constructed using Binford's techniques in Chapter Four. In addition to site descriptive information, Chapter Five also contains a discussion of methods used to collect zooarchaeological data. The nature of the field situation and data requirements were such that most of the work was accomplished with the aid of an Apple microcomputer and the University of Alberta's mainframe computer system.

Muskox procurement is considered in Chapter Six, and models of muskox use are examined with an analysis of osteological materials recorded at three archaeological sites. The results of this study have implications for other research topics, such as the interpretation of patterning in the zooarchaeological record, and the investigation of prehistoric resource management. These issues, as well as potential research directions for future faunal analysis, are discussed in Chapter Seven.

II. The Copper Inuit: Early Twentieth Century Subsistence Practices

Introduction

The Copper Inuit inhabited an extensive area in the west-central Arctic. This discussion will only focus on those groups who seasonally occupied Coronation Gulf, southwest Victoria Island , and the southeast coast of Banks Island in the early 20th century. It was these Inuit and their immediate ancestors who utilized portions of interior, northern Banks Island and the Investigator cache during the 19th century. The first part of this chapter concerns the use of Banks Island by the Copper Inuit. It is based upon the works of Stefansson (1913; 1921) who made contact with northwest Victoria Island people, the Kanghiryuarmiut, in 1912. Informants, especially an older Prince Albert Sound native, Pamiungittok, provided Stefansson with much of his knowledge of Banks Island native history. Stefansson's account of the Arctic and its people provides fascinating reading, although at least one historian (Diubaldo 1978) has argued that his statements often distorted or sensationalized the facts for public consumption.

The second part of this chapter concentrates on Copper Inuit settlement and subsistence as described by Jenness (1922). Given that problems are inherent in the use of ethnographic analogy to substantiate archaeological conclusions (for example, see Wobst 1978 and Trigger 1981), the purpose of the second section is to describe aspects of Copper Inuit subsistence activities which offer testable implications for interpreting Banks Island zooarchaeological data. These include: site seasonality, and resource procurement and utilization. The focus is on subsistence activities practiced on land rather than on sea ice, since it is primarily evidence of the former which is preserved in the archaeological record.

Jenness spent almost an entire year (1915) with a family of Copper Inuit from Coronation Gulf. It should be noted at the outset that he was observing people in the post-contact period. However, because of their geographical isolation, these Copper Inuit had not experienced much "westernization". Jenness was a meticulous observer, and his monographs on the Copper Inuit way of life (1922) and material culture (1946) provide a detailed record of these Arctic people in the early twentieth century. Since caribou was considered a favored terrestrial food, a brief comparison with Nunamiut use of caribou is made in the final section of this chapter.

The Copper Inuit and Banks Island

On the thirteenth of May 1912, Stefansson (1921:279) encountered a large encampment of 27 snowhouses in Prince Albert Sound. A few skin tents were also in use, and a population of about 200 people was estimated. At that time, some families were already packing up and travelling into the interior of Victoria Island for their summer fishing and hunting (Stefansson 1921:301).

Stefansson (1921:281) questioned some of the Kanghiryuarmiut about their seasonal movements. He was informed that no people lived on Banks Island during the summer but that various points on the southeast coast between De Salis Bay and Nelson Head were utilized during the winter. In addition, some Victoria Island families occasionally traveled as far south as Great Bear Lake to reach their summer hunting grounds, and to obtain wood (Stefansson 1921:273). The extent of people's geographical knowledge was remarkable, for they knew where Mercy Bay was located, and that McClure's ship, the H.M.S. Investigator, had been abandoned there (Stefansson 1921:284).

Family-based groups reassembled in Prince Albert Sound during the fall. Some of them proceeded to the southeast coast of Banks Island once the sea ice was sufficiently stable to make a crossing. Polar bears were the primary food resource there during the winter, although some families did engage in sealing offshore and to the east of Nelson Head. Caribou and muskoxen were not hunted during the winter, even though people were aware of their presence on the island. In the spring, families aggregated in the Sound before going off to their respective inland hunting grounds (Stefansson 1921:288-289).

According to Pamiungittok, who had visited Collinson's ship in Walker Bay in 1852 when he was eight years old, Banks Island was formerly occupied during the summer. The following quotation from Stefansson (1921:288) is of Pamiungittok's recollections of the Banks Islanders:

> There were numerous people once resident in Banks Island summers, and on the ice near it winters. These are all dead some of hunger in (or near) Banks Island and the last party on the ice of the mouth of Prince Albert Sound - these last died "because they had no food in their stomachs and because they had no oil (for fuel) to make water with."

Stefansson (1921:289-290) records that Pamiungittok went on to say:

> The Banks Island people used to be well off. They killed so many deer and (musk) oxen that their dried meat sometimes lasted year round. They got to killing each other. One man killed had relatives in the Sound. For this reason (ie. because of witchcraft practiced by the dead man's relatives in the Sound) food became scarce (in Banks Island); there were no seals for food or fuel and other people died of hunger - those that had not been murdered in the feuds.

People had formerly gone to Banks Island during the summer in order to reach Mercy Bay where the Investigator had been abandoned. Stefansson (1921:240) states that the ship was discovered by the Inuit in less than a half dozen years after it was left in the ice. He (1921:240) also says that news of the ship and/or its cache travelled "as far south as Coronation Gulf and east towards King William Island". Exotic goods were collected over the next 20 or 30 years by "certain families making the journey one year and other families another year" (Stefansson 1921:241). The last trip to Mercy Bay for the purposes of collecting softwood and iron occurred sometime around 1895 (Stefansson 1914:17).

In 1914, Stefansson travelled on Banks Island. He did not encounter any Inuit, but did discover numerous archaeological sites containing muskox bones and shavings of Investigator wood. He concluded that families making the overland journey to Mercy Bay during the summer had subsisted on muskoxen, because these animals had been more abundant than caribou and also much easier to kill. Concerning muskox hunting strategy, Stefansson (1921:241) wrote:

> The Eskimo method of hunting is to sick a few dogs at the herd, which then forms a defensive circle, the large animals on the outside and the calves and weaker ones in the center. This defense does well against the dogs as it would against a similar attack of wolves, but is of no avail against the Eskimos, who lash their hunting knives to their walking sticks, converting them into lances and go up and stab the entire herd. Or they may use their bows and copper-pointed arrows with equal effect.

Stefansson (1921:241) correlated the former summer abundance of people on Banks Island with the contemporary absence of muskoxen on the island and concluded that the Copper Inuit had hunted the animals to extinction: "We now know that the giving out of the iron in Mercy Bay must have been about coincident with their (musk oxen) extinction". Evidence to support his hypothesis consisted of the numerous muskox bones which he found in Banks Island archaeological sites, and the story which Pamiungittok told him that people had starved to death. Stefansson's extinction hypothesis will be considered in Chapter Seven.

Copper Inuit seasonal round

According to Jenness (1922:13), who lived with a Coronation Gulf family and accompanied them on their seasonal round, the Copper Inuit partitioned the year into five seasons: winter (November to the end of February), early spring (March to mid or late April), spring proper (the end of April to the beginning of July or whenever the ground was bare of snow), summer (July to early September) and fall (the middle of September to mid November).

Early spring was the season when people moved from snow houses into skin tents (Jenness 1922:77-78). These tents were relatively large (4.6 x 3.3 x 2.1 m high) and quite heavy (approximately 32 kg). Sealing was still the main subsistence activity, but settlements were short-lived and rarely lasted longer than two or three weeks.

The time when people left the sea ice varied, but departure frequently occurred in May (Jenness 1922:121). The same pattern was observed by Stefansson. Jenness noted that some families moved inland immediately, while others remained on the coast for several weeks. He (1922:122) wrote:

> Often, tribes partially break up as soon as their blubber caches are made, though the full disbandment does not take place till early summer. Many families even break off while the main body is still sealing on the ice, as there are many different hunting and fishing grounds, and every man is free to choose his own.

Before families set off into the interior with their lighter and smaller summer tents, caches containing blubber, winter clothing, and gear were deposited on the coast (Jenness 1922:121). Thus, the spring caching sites often functioned as fall assembling places.

Family groups spent July fishing on southwest Victoria Island. Groups occasionally joined for a few days, and then went off on their separate ways again. Jenness (1922:122-123) suggests that the fragmentation of groups was due to the lack of big fish runs in the area. However, aggregates of from six to twelve families sometimes remained together organizing caribou drives in valleys where animals were particularly abundant (Jenness 1922:124).

Depending on hunting success, late summer was a period of feast or famine. The Copper Inuit greatly diversified their subsistence base. Jenness (1922:124) stated that: "No fowl of the air, no creature of the land, no fish in the water is too great or too small to attract their notice at this time."

Meat and fish were cached during the summer for consumption in November, before the sealing season (Jenness 1922:102). Migration back to the coast usually occurred after the first snowfall, sometime in September. Families reassembled at their spring cache sites to collect winter clothing and gear, and to prepare for winter sealing, which might not get underway until December.

> Normally the different groups remain in their various assembling places until it is time to move out on the ice and begin sealing. They live during this transition period on the dried fish and caribou meat they have stored away during the summer, and the frozen meat and fish kept from the fall (Jenness

1922:111).

Winter and early spring were spent sealing and polar bear hunting out on the sea ice. These activities required a communal effort (Damas 1969; 1972). In addition, the winter season was a period of intense social intercourse among families assembled out on the ice. Consequently, it can be anticipated from evidence presented in the accounts of both Stefansson and Jenness that Copper Inuit families scheduled trips to Mercy Bay at any time except the sealing season. This would include the months of May through mid-November (spring proper through fall).

Food resource selection

Caribou were the preferred summer food of the Copper Inuit, and their skins were essential for the manufacture of winter clothing. Muskoxen, the only other large terrestrial mammal available in summer, were infrequently taken. This may have been due to their relative scarcity on southeastern Victoria Island when Jenness made his observations. Muskox horns were valued as a raw material but their skins were considered too heavy for clothing, although they were used as sleeping robes.

Like Stefansson, Jenness (1922:150) noted that muskoxen were easily hunted and that they could even be driven right into camp before the entire herd was dispatched. Such a procurement strategy obviously reduced transportation effort, and eliminated decisions concerning what carcass parts to abandon or remove from the kill-site.

Caribou hunting involved stalking by individual hunters and organizing communal drives by several families (Jenness 1922). Although the animals were common on Victoria Island, they were usually found singly or in small groups. During caribou migrations to and from the mainland across Coronation Gulf in the fall and spring, larger kills were possible (Jenness 1922).

Caribou utilization

Neither Stefansson nor Jenness witnessed the dispatch and butchery of a muskox carcass. However, Jenness did provide several descriptions concerning the preparation and utilization of caribou carcasses. He (1922:102-103) wrote:

> In cutting up a caribou the Eskimo is careful to preserve every particle of fat, even around the intestines ....As a rule the first parts of a caribou that are cooked, besides the tongue and the heart are the fore- and hind quarters, the bones of which contain the much prized marrow....After these parts come the ribs and the sternum, which are often coated with a layer of fat; the ribs are sometimes cracked between the teeth in order to extract the tiny quantity of marrow they contain. Last of all come the chine, the neck and head; the last is split into four pieces, first down and then across, before being put into the pot, and the brains as well as the marrow of the jaw bones, are carefully picked out and cleaned.

Marrow from caribou leg bones was considered a delicacy (Jenness 1922:103). Bones were prepared for marrow extraction by removing meat and sinew. An articular end was cracked off with a hammerstone, and then a sharper edged stone was employed to split the bone longitudinally. Marrow bones were cached along with the meat during the summer. Jenness (1922:126) stated:

> I have seen a man take a bone from a rotten caribou - meat cached more than a year before, crack it and eat the marrow with apparent relish.

Meat was dried, weather conditions permitting. The drying rack was constructed by placing a pole or board between two pillars of piled stones (Jenness 1922:103). Thin strips of sliced meat were laid over the pole. Fish were dried in the same manner. Not all of the caribou meat was considered of equal drying suitability. In the spring, those parts most likely to be consumed rather than dried included: the head, chine, shoulders and thighs (Jenness 1922:101).

The Copper Inuit also made bone grease which Jenness (1922:103) says was:

> ...esteemed more highly perhaps than any other food the natives possess....Sometimes the Eskimos preserve all the bones that have contained marrow - the vertebrae, ribs, leg and feet bones - pound them into fragments and boil them slowly over an open fire. The fat that separates out on the surface is skimmed off with a ladle of musk-ox horn and poured into some convenient receptacle...

Stefansson also inferred that muskox bones had been processed for marrow and grease on Banks Island. In some of the archaeological sites which he visited, he (1921:257) found that:

> ...the bones have been broken for marrow and many of them gnawed by dogs, and sometimes there is evidence that the bones were pounded up and boiled to secure the last bit of fat from them.

Comparison with Nunamiut caribou use

The most important terrestrial wild food in the contemporary Nunamiut diet is caribou (Binford 1978). Many decisions are involved in determining how a caribou carcass is used. They are significantly influenced by knowledge concerning the quantity and quality of meat, marrow and bone grease present in each part of the animal. Binford (1978) constructs food utility indices to measure variation in the amount of foodstuffs available from caribou and sheep body parts. He incorporates these indices into models to predict how carcass parts are variously used in the context of different Nunamiut subsistence activities.

Historical data concerning Copper Inuit use of caribou are meager. However, they suggest that foodstuffs similar to those obtained by the Nunamiut from caribou were extracted from dispatched animals. Meat was removed from carcasses and prepared for various uses (eg. immediate or deferred consumption), and it was also reported that both marrow and grease were extracted from caribou bones. A Binfordian zooarchaeological analysis of Copper Inuit sites containing caribou remains would prove interesting for determining whether or not these animals were utilized in ways similar to those employed by the Nunamiut. However, caribou bones occurred rarely in the sites investigated in this study. They compose less than 1% of the osteological assemblages examined.

Muskoxen were the targets of food procurement activities on northern Banks Island during the 19th century. Their carcasses would have provided the same kinds of foodstuffs (meat, marrow and grease) as did caribou carcasses. Utilization of muskoxen for subsistence purposes by historic Copper Inuit is poorly documented; however, Binford's zooarchaeological approach provides a method for investigating it. In order to evaluate how these animals were procured and used, information about muskox biology and behavior are presented in the next chapter.

III. Muskox Biology and Behavior Relevant to Human Exploitation

Introduction

The information presented on muskoxen was selected for its potential predictive value for understanding how people utilized animal resources. Frequently in zooarchaeological studies all that appears is an inventory of biological and behavioral generalities concerning identified wild food species. Explanations concerning why such information is included are rarely addressed, although there is an implicit assumption that the reader will be better informed from the data about man and animal interactions.

It is advocated here that inclusion of species biological and behavioral information is dependent on both the anthropological questions under examination, and the archaeological data available for study. Therefore, muskoxen biological information which can be used to construct food utility indices is presented (see Chapter Four). Other data (both biological and behavioral) which are required for examining the hypothesis that Copper Inuit extirpated muskoxen on Banks Island are also included.

An equally important issue concerns how wildlife data should be presented. Just as the "normative approach" is inadequate for explaining human behavior, so is the "average animal" description for understanding how people interacted with individuals of a particular food species. Therefore, variations in both physical characteristics and behavior of muskoxen are provided.

In addition, relevant wildlife information should be collected on animal populations living in communities thought to resemble those near the site during its occupation (see Smith 1975). When this is not feasible, biological and behavioral data on animals living in environments unlike those inferred for the archaeological sites needs to be evaluated for difference that might be significant.

Fortunately, Banks Island has experienced very little environmental change in the last century. Recent human activity on its northern portion has been limited to the Copper Inuit occupation during the latter half of the 19th century, and to energy resources exploration during the 1970s (see for example, Carruthers 1976). Unlike the majority of mid-latitudinal environments, northern Banks Island is essentially pristine. It is one of the few regions where western technology has had little or no impact on plant and animal communities. Therefore, contemporary muskox distribution, abundance and behavior is probably quite similar to that when Victoria Island Copper Inuit initiated forays to the Investigator and/or its cache in Mercy Bay. In fact, Wilkinson and Shank (1975:111) conclude from their research that:

> ...north central Banks Island is today comparable from the viewpoint of humans exploiting it, to what

it was when it was being used by the prehistoric Inuit over the past three millennia.

In the sections on muskox biology and behavior which follow, the focus will be on Banks Island animals. The literature on this population is not extensive, and is supplemented with information collected on muskoxen elsewhere. The wildlife data are used in conjunction with archaeological and ethnographical material to examine several general topics in Chapters Six and Seven, including: 1) food utilization by occupants of each site, 2) animal harvesting choices and procurement strategies, and 3) impact of hunting on muskox populations.

Physical characteristics

Biological affinities

Muskoxen belong to the family *Bovidae* (for detailed taxonomic discussion see Allen 1913; Hone 1934; Tener 1965). They are close relatives of sheep and goats based upon serological evidence provided by Moody (1958). Urquhart (1982:3) states that muskoxen are most closely related to goats but does not provide support for his assertion.

Animal weight

Few weights have been obtained from wild muskoxen. In fact, very litle data on the distribution of muscle and fat or even animal growth are available. However, an on-going program to collect biological information from captive Banks Island muskox calves is underway at the Western College of

Veterinary Medicine in Saskatoon, Saskatchewan, Canada (Anonymous 1982:14 and P. Flood, pers. comm. 1982). A literature summary of wild animal weights is presented in Table 3.1. The average weight of an adult male is about 290 kg (640 lb). However, it should be noted that weights for what are labelled adult males vary from approximately 191 to 409 kg. There are few comparable data on wild, adult females.

Weights have been taken from both wild males and females which were 10, 11, 22 and 36 months old. Females less than 24 months weigh about 95% that of their male contemporaries. However, by the time the animals are three years old, males may weigh about 10% more than females. Wilkinson (1973) concluded that an adult cow weighs about 2/3 of an adult bull. Therefore, the average weight of an adult cow would be around 194 kg (427 lb).

Seasonal fluctuation in adult animal weight occurs in response to 1) nutrition, 2) environmental stress and 3) reproductive condition (Hubert 1974:60). Bulls are heaviest before the onset of the rut but may lose up to 5% of their body weight in August and September. Both males and females experience a positive weight change during early winter, and a negative weight change in late winter perhaps in response to food availability (Hubert 1974:74). Cows gain weight during the breeding season, whereas pregnant and lactating females lose weight in the spring (Hubert 1974:74).

Table 3.1

Weights of Male and Female Wild Muskoxen

Sex	Age	Weight(kg.)	Season	Location	Reference
M	ad.	ca. 409	August	Aylmer Lake	cited in Tener, 1965[1]
M	ad.	373	August	Melville Is., NWT	cited in Tener, 1965[1]
M	ad.	325	July	Lake Hazen	Tener, 1965
M	ad.	ca. 317	August	Thelon Game Sanctuary	cited in Tener, 1965[1]
M	ad.	288 (n=2)	February	Devon Island, NWT	Hubert, 1974
M	ad.	266 (n=5)	May	Devon Island, NWT	Hubert, 1974
M	ad.	263	August	Thelon Game Sanctuary	Hanbury, 1904
M	ad.	259	July	Melville Is., NWT	Miller, unpublished in Hubert, 1974
M	ad.	191	July	Melville Is., NWT	Miller, unpublished in Hubert, 1974
M	38 mo.	182	July	Thelon Game Sanctuary	Tener, 1965
M	34 mo.	177	February	Devon Island, NWT	Hubert, 1974
M	23 mo.	119 (n=6)	Spring	Nunivak Is., Alaska	cited in Wilkinson, 1973
M	22 mo.	98 (n=3)	March	Banks Island, NWT	Wilkinson and Shank, 1974
M	11 mo.	78 (n=30)	Spring	Nunivak Is., Alaska	cited in Wilkinson, 1973
M	11 mo.	94 (n=5)	March	Banks Island, NWT	NWT Government in Hubert, 1974
M	10 mo.	86 (n=2)	March	Banks Island, NWT	Wilkinson and Shank, 1974
F	36 mo.	173 (n=2)	Spring	Nunivak Is., Alaska	cited in Wilkinson, 1973
F	35 mo.	127 (n=3)	Spring	Nunivak Is., Alaska	cited in Wilkinson, 1973
F	23 mo.	109 (n=6)	Spring	Nunivak Is., Alaska	cited in Wilkinson, 1973
F	22 mo.	96 (n=2)	March	Banks Island, NWT	Wilkinson and Shank, 1974
F	11 mo.	75 (n=33)	Spring	Nunivak Is., Alaska	cited in Wilkinson, 1973
F	11 mo.	90 (n=3)	March	Banks Island, NWT	NWT Government in Hubert, 1974
F	10 mo.	77	March	Banks Island, NWT	Wilkinson and Shank, 1974
F	1 week	17	May	Fosheim Peninsula	Tener, 1965
F	1 day	12	April	Thelon Game Sanctuary	cited in Tener, 1965[1]

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1. These weights are provided in Tener 1965:54, Table 18.

Some of the weights listed in Table 3.1 indicate that weight variation may exist among regional populations. Animals on Banks Island appear to be heavier than those on Nunivak Island, Alaska. This may indicate a nutritional difference, since provisioned muskoxen raised on high plane nutrition are more than 50% heavier than are wild muskoxen (Tener 1965:53).

Only a single record exists in the literature on weights for a piece butchered muskox (Hanbury 1904:13). The animal, an adult male, was killed on the Barrengrounds in the early fall when its weight would have been low relative to summer and early winter. Anatomical part weights and gross weight for this bull are listed in Table 3.2. The weight total of 262.6 kg may be under-representative since organ weights, such as that for the kidneys, are not listed by Hanbury. In addition, Hanbury estimated blood weight and it may be too low for an animal that large. However, this weight for an adult male is certainly within the range of adult weights listed in Table 3.1.

Herd characteristics

Seasonal variation

The social structure of muskoxen herds is best described as very open (Gray 1973:173). Herd size and composition are different throughout the year and can change daily, as well as seasonally. Herd size ranges from 2 to over 100 individuals, and the largest herds usually occur in

Table 3.2

Gross Weight of Muskox Body Parts[1]

Anatomical Part	Weight (kg)
1 shoulder with foreleg and hoof	20.4
1 shoulder with foreleg and hoof	22.7
1 hind leg with shank and hoof	19.5
1 hind leg with shank and hoof	19.5
entrails	20.9
paunch (full)	36.3
liver	3.2
heart and lungs	5.9
blood	4.5
head and neck	34.0
brisket	5.9
ribs	7.7
ribs and part of back	23.6
rump	15.9
hide	17.2
off piece of belly flap	3.2
extras	2.3
Total	262.6

1. Weight data from Hanbury (1904:13).

winter. Tener (1965:86) gives a mean winter herd size of 19.7 muskoxen for the Canadian Arctic. Gray (1973:39) observed winter herds on Bathurst Island ranging from five to more than fifteen individuals. There is no comparable literature for Banks Island winter herd size.

Miller et al. (1977:28) suggest that larger winter groups represent the coalescence of several summer herds. This happens because smaller summer groups tend to congregate on restricted but more productive sedge meadows in winter. Animals may also group in bigger herds during the winter for mutual defense (Tener 1965:87).

Winter herds fragment in spring, and Urquhart (1973:59) reports that this event coincides with the period of most extensive movements of the Banks Island muskoxen during the year. He does not discuss how great the movements are, however. Wilkinson and Shank (1974) show that the daily summer movements of northern Banks Island animals are limited to short forays between feeding areas. Herds were sometimes resighted in the same area after several days.

On Bathurst Island, an intensive study of muskoxen movements was initiated by Gray (1979). He found that movements were slow, and that animals did not cover large distances while feeding. Animals sighted at least three times over a four year period traveled a mean minimum distance of 82 km from their original sighting location. The greatest straight line distance recorded, however, was 42 km. These data suggest that muskoxen are relatively sedentary when compared with other ungulates, such as caribou.

Animals disperse somewhat after calving to take advantage of greater food abundance. In June 1970, Kevan (1974:63) counted 26 herds with calves on northern Banks Island. Herd size varied from 3 to 60 animals with an average of 15.3. The high average herd size was in part due to a large calf crop. Kevan (1974:63) reported that herds without calves averaged 4.5 muskoxen but varied from 3 to 6, and that solitary or paired animals accounted for 8.6% of the June population.

Numbers of animals seen by the author (June 25 - July 13) around one of the archaeological sites (Kuptana or PjRa-18), and while on survey along the northeast Banks coast between the Haogak site and Johnson Point (July 16 - August 4) in 1982, are presented in Tables 3.3 and 3.4. Observations were made over a three week period in each area. Table 3.3 shows that herds with calves around the Kuptana Site ranged from 3 to 34 animals. The average herd size was 14.4 muskoxen. Only two herds without calves were seen, one with four and the other with eight individuals. The proportion of solitary animals as a percentage of total animals observed was 14.4 percent. This figure is much higher than that cited by Kevan. One explanation may be that solitary animals wander over a larger area than herds. Therefore, they would be counted more often from a fixed observational point.

Table 3.3

1982 Observations of Muskoxen, Thompson River, Banks Island, N.W.T.

Date Oberved	Solitary Animals	Herds	Animals in Herds	Calves in Herds
June 25	0	1	4	0
27	0	2	10, 3	2, 1
28	0	1	14	4
29	4	0	0	0
30	0	2	8, 14	0, 4
July 2	7	1	34	4
3	0	1	17	1
6	1	1	9	1
8	1	0	0	0
10	1	0	0	0
11	3	0	0	0
13	2	0	0	0
Totals:	19	9	113	17

Table 3.4

1982 Observations of Muskoxen, Coastal Survey, Banks Island, N.W.T.

Date Oberved	Solitary Animals	Herds	Animals in Herds	Calves in Herds
July 16	0	2	6,4	0, 0
18	0	1	12	3
20	0	1	8	0
21	0	1	11	2
24	0	1	6	0
29	0	1	4	0
30	0	1	4	0
31	0	1	9	0
Aug. 3	0	1	3	0
4	0	2	7, 12	2, 2
Totals:	0	12	86	9

Herds with calves seen on the coastal survey were smaller, and there were no solitary animals. They contained 7 to 12 muskoxen with an average of 10.7. Eight herds without calves were seen, ranging in size from 3 to 11 animals and including single sex groups. Average herd size was 7.3 individuals. Differences in herd size and composition between the coast and interior are possibly related to variation in forage quality and availability.

Solitary or paired animals become common during the summer. With very few exceptions, they are males. Why certain individuals take up a solitary existence is unclear. Tener (1965:28) believed that it resulted from rivalry when one bull lost to another for possession of a herd. He also suggested that far ranging bulls might precede the colonization of a new region (Tener 1965:89). Dominant bulls participate most but not exclusively in defense against predators, prevent other sexually mature bulls from mating with cows, and spend a great deal of time in active courtship (Gray 1979:43). Solitary bulls can become dominant animals and, therefore, their importance to the muskoxen population may be significant (Gray 1979:44).

Muskox herds begin to aggregate after the breeding season in August and September (Tener 1965:89). The larger fall and winter groups have a sex ratio approaching 1:1. This is in contrast with the summer when males may leave the herd or when small herds of same sex animals occur.

Age structure

No reliable data exist on the age composition of muskox herds. Juvenile animals are difficult to age unless examined closely. Aerial census techniques generally do not permit close enough observation for differentiating subadults into specific age groups.

Parker et al. (1975:5) examined 23 muskox carcasses on Bathurst Island, and 26 carcasses on Melville Island. The animals had died of starvation during the severe winter of 1973-74. Both death populations contained a high percentage of yearlings (26.9% on Bathurst Island and 30.7% on Melville Island). The percentage of juveniles (animals three years old or less) in the Bathurst Island death assemblage was 26.9%, whereas it was 53.7% on Melville Island. Neither population contained individuals between the ages of four and eight years old. Adults of nine years and older composed 69.2% of the Bathust Island death population and 45.8% of the Melville island group.

Parker et al. (1975:9) point out that malnutrition usually affects young and old members of a population most severely. Their data on muskox death populations certainly supports this conclusion. It also suggests that several severe winters could result in a very low percentage of juvenile animals surviving in a population. Calf production following severe winters could also be low (see below), further accentuating the adult component of the muskox population.

Distribution

Kevan (1974:259) concluded that muskoxen were restricted to the eastern portion of Banks Island. However, Urquhart (1982:19) shows that they are dispersed over most of the island but are not evenly distributed. The Thomsen and Parker River areas are reported to have the highest densities north of 73 degrees where muskoxen occur year round (Urquhart 1973:58). Animal density estimates vary from 18 to 213 individuals per 100 square kilometers in these areas (Vincent and Gunn 1981:176).

Food availability is an important reason why muskoxen are found year round in the Thomsen and Parker River drainages. Both regions contain mesic and hydric meadows with grasses and lush sedges that are preferred summer food (Wilkinson and Shank 1974:92). Sedges are also a primary winter food for muskoxen unless excessive snow cover forces animals to feed on willows, grasses and herbs found in snow-free areas (Parker 1978:5; Urquhart 1982:6). Year round food availability in these northern drainages is also indicated by the observation that there is no significant difference in the distribution of muskoxen between the calving and rutting seasons (Urquhart 1973:9).

Muskox productivity

Calf production

Most calving occurs in late April and May throughout the Canadian Arctic (Hubert 1974:49). The literature contains few weights for newborn calves, although a weight of 12 kg for a day old female is listed in Table 3.1. The age at which wild cows begin producing offspring is strongly influenced by their nutritional status. Tener (1965:82) suggests an age of four years; however, the generally accepted age for a healthy, wild cow is three years (Gunn 1982). This age is difficult to substantiate from field observational data. Well fed, captive, muskox cows successfully reproduce as young as two to three years (Tener 1965:82), lending support to the hypothesis that nutritional status is probably the decisive factor in calving age.

Male sexual maturity seems to depend on nutritional condition as well. Tener (1965:82) suggests that wild, muskox bulls reach sexual maturity at six years but that captive individuals may become sexually active at a much younger age. However, age of sexual maturity and breeding age for male muskoxen do not necessarily coincide. Social factors related to dominance hierarchy in herd structure are important qualifications.

Calving frequency, and the occurrence of twinning are also influenced by animal nutritional status. Tener (1965:82) states that calves are usually produced every second year. However, more recent data demonstrate that calves may be produced yearly if cows are in good condition (Gunn 1982). In 1973, Wilkinson and Shank (1974:280) observed cows with both calves and yearlings on northern Banks Island. This demonstrated to them that some animals were producing offspring every year. Similar observations were made by this writer on northern Banks Island during the summer of 1982. In addition, two calves were observed in close proximity to a single female on two separate occasions. When frightened by the writer's presence, both calves immediately sought the company of the same female. Twinning is suggested by these observations, although the possibility of orphaned calves attaching themselves to cows already with a calf cannot be dismissed.

Statistics on muskox calf production in the Canadian Arctic islands indicate a great amount of spatial and temporal variation. The highest muskox calf crop (the proportion of calves to total population) ever documented was 31.9% on Banks Island in 1971 (Urquhart 1973:60). On northern Banks Island, the calf crop averaged 21% in 1973 (Wilkinson and Shank 1974:276-278). Reasons for annual variation may include: sampling error, nutritional condition of cows, and predation (Tener 1965:78).

Calf production for the period 1970-1973 on northern Banks Island was greater than twice the average (10.5%) for elsewhere in the Arctic (Wilkinson and Shank 1974:276). The proportion of calves to adults is related to the quality and quantity of forage available to muskoxen in that region. One hundred and thirty-two different animals were observed within a 3 km radius of the Kuptana site in the summer of 1982 (Table 3.3). The number of calves as a percentage of all animals seen (animals in herds, as well as solitary bulls) was 12.9%. A total of 86 muskoxen, all in herds, were counted on the 1982 coastal survey (Table 3.4). The percentage of calves in this sample was 10.5%.

These figures are lower than those derived by Wilkinson and Shank in 1973, but are similar to the average reported for the Arctic Islands. Aside from sampling error, other explanations for the lower calf production include: 1) density dependent factors which may have influenced calf production, and 2) the 1981-82 winter which may have been so severe that neonatal mortality was high and that females in poor nutritional condition were incapable of carrying fetuses to term.

More important than gross production is calf survival. This is measured by determining the percentage of yearlings within the muskox population and comparing it with the calf crop. Urquhart (1973:60) notes that 71.8% of the 1970 northern Banks Island calf crop survived into 1971, and that approximately 43.6% of the 1971 calf crop survived to July 1972. Wilkinson and Shank (1974:279) cite a figure of 9% for the proportion of yearlings to all other animals on the northern part of the island in 1973. They admittedly had difficulty differentiating yearlings from two- and three-year olds, and suggested that calf survival probably exceeded 50%.

Mortality factors

According to Hubert (1974:98), Truelove Lowland muskoxen only harvest a small proportion of the total standing crop. He argues that natural regulating factors maintain the wild muskox population below the sustained yield of its food supply. Wilkinson and Shank (1974:236-237) also concluded that muskoxen on northern Banks Island were well within the carrying capacity of their summer range, at least in 1973.

However, this does not mean that density dependent factors are not playing a role in muskox mortality. Combat between bulls for access to females during the mating season may be a significant source of male mortality when animal densities are relatively high. Twelve muskox carcasses were observed on northern Banks Island in 1973 (Wilkinson and Shank 1974:165-167). Death occurred sometime in late winter for six of them. Another six, which were males, were found recently dead in August. Death was attributed to combat as evidenced by gore wounds, severe contusions, and blood in mouths and noses.

High muskox densities occur on Bailey Peninsula, Melville Island, N.W.T. A total of 85 recent muskox carcasses were observed there in August 1983, and over 75% of them were adult males (A. Gunn, pers. comm. 1983). The proportionally large number of males may have died as a consequence of combined density dependent and independent factors. These bulls may have begun the winter in a weakened state following intense competition during the rut. If the winter was particularly severe, then they may have experienced depletion of fat reserves and perished.

Density independent factors are frequently credited with responsibility for the abrupt changes recorded in some muskox populations. The most important agent has probably been human predation (Burch 1974). Another critical factor is snow cover. Prolonged, deep snow can prevent animals from obtaining food, resulting in starvation and subsequent die off in large numbers. This occurred on Bathurst Island and other Canadian Arctic islands during the severe winter of 1973-74 (Parker et al. 1975:1-10). In addition, heavy snow cover could result in interspecific competition between muskox and caribou for vegetation on exposed slopes and wind-swept ridges (Parker 1978:5). Although caribou are ubiquitous on Banks Island during the winter, many of them migrate south and west during September and October (Urquhart 1973:19). A lower winter caribou density in the north would certainly lessen any competition with muskoxen for forage during severe winter conditions.

Accidental death and wolf predation do not appear to affect adult muskox mortality rates significantly. Wolves have rarely been observed bringing down mature muskoxen successfully (for exceptions, see MacDonald 1968:19; Gray 1970). Most often, animals flee to the nearest high ground where adult bulls keep the predators at bay, while the remainder of the herd maintains a tight defense posture. Barrenground grizzly bears are also known to kill muskoxen by ambushing them, but this is probably a rare phenomenon (Gunn and Miller 1982:545-546).

Food availability and wolf predation may significantly affect the survival of animals in their first year. Calf mortality due to predation may be high in situations where bull muskoxen are not present to defend the young animals. Another reason to explain the substantial difference between the number of calves counted one year and the number of yearlings sighted the next is sampling error.

Longevity

Few records bear directly on determining how long wild muskoxen live. A recently dead female was found which had been tagged 23 years previously (Buckley et al. 1954:456). The teeth were still in relatively good condition suggesting a potential lifespan of 25 years. Based on dental annuli counts, one bull had lived nineteen years before starving to death on Melville Island in the winter of 1973-74 (Parker et al. 1975:5). Using a similar aging technique, an 11 year old animal was identified in the Haogak Site (PhPo-3) bone sample (Savelle and Will 1982:6). These data imply that wild muskoxen do have a relatively long natural lifespan. If so, the number of years that females remain reproductive may also be great, although there is no documentation on this subject.

Abundance

Considerable ambiguity exists in the literature concerning the abundance of muskoxen on Banks Island during this century. A major problem has been the lack of comparable survey techniques and coverage over the island for the period 1911-1982. Most researchers do not accept population estimates made before systematic, aerial surveys in the 1970s (Wilkinson and Shank 1974:200). Previous to this time, animal sightings were sporadic and based on foot survey over limited portions of the island. Muskox population estimates made during this period are presented in Table 3.5.

Urquhart (1973:61) estimated that there were about 3,800 muskoxen on Banks Island in May 1972. In less than ten years, an updated estimate of 19,328 animals was presented in the literature (Vincent and Gunn 1981:177). If these estimates are reasonably accurate, then an annual growth rate of between 20-25% occurred between 1972 and 1980. This percentage is close to the maximum rate of population growth postulated for muskoxen (Leslie, in Tener 1965:154). However, Vincent and Gunn (1981:177) point out that Leslie's calculations were based upon cows breeding at three years of age, and calving occurring every other year. Factors which they believe have contributed to this phenomenal growth rate include: 1) annual calving by cows, 2) a hunting prohibition not lifted until 1976, 3) a reduction in the Banks Island wolf population due to a poisoning campaign in the 1950s, and 4) the reintroduction of a population into a nutritionally rich environment with little or no competition.

Table 3.5

Population Estimates of Banks Island Muskoxen for the Period: 1911-1982

Period	Estimate	Source[1]
1911-1949	very few	Stefansson (1921)
1958	100	Tener (1965)
1959	100	MacPherson (1960)
1961	100+	Yont (1961)
1963	150	Harrington (1963)
1967	800	Williams (1967)
1970 June	1,200-1,800	Kevan (1972)
1971 June	3,250-3,350	Urquhart (1972)
1972 May	3,800+	Urquhart (1973:61)
1979-1980	19,328	Vincent and Gunn (1981:177)
1982	9,400	Latour (in Urquhart (1982:4)

1. Data before 1979 from Urquhart (1973:61).

A hunting ban imposed in 1917 (Clarke 1940:1) probably did little to affect the Banks Island muskox population. Muskox skins were no longer considered valuable, and few sportsmen possessed the resources to visit Banks Island. Even after the modern Inuit population located itself along the western side of the island in the 1920s, people met subsistence needs with caribou (Usher 1970; Urquhart 1973:16). Arctic fox trapping provided the economic mainstay for the community (Usher 1970). It was not until the 1970's, when Sachs Harbour residents voiced their concerns that the large muskox population might be responsible for the decline in caribou numbers, that limited hunting for a commercial market was considered. Even now, very few animals are actually taken (Anonymous 1982).

As noted previously, there is insufficient evidence to evaluate the role of wolves in reducing the Banks Island muskoxen population. Muskoxen have behavioral adaptations which make wolf predation difficult.

The rapid population growth which cannot easily be justified by annual recruitment rates may be partially due to animal migration to Banks Island from nearby Victoria Island (Urquhart 1982:19). Muskox migration between arctic islands has not received adequate study, although there is evidence for its occurrence. Miller et al. (1977:39) point out that muskoxen from Melville Island must have recolonized Prince Patrick Island, since none were observed in 1961 but around 100 lived there in 1973.

The most recent estimate of the Banks Island muskox population is 9,400 individuals (Latour,in Urquhart 1982:4). This represents a 50% reduction in the number of animals estimated by Vincent and Gunn only two years before. Severe climatic conditions over the previous two winters may have contributed to a reduction in the animal population, however, there is no evidence to support or refute this claim. Emigration to nearby islands might also have occurred, but reasons for such movement are unknown. The March 1979 muskox population survey covered the island south of 73 degrees north, and the results of it were combined with those obtained from the 1980 survey conducted in the same month north of 73 degrees latitude. Vincent and Gunn (1981:176) argue that large scale movements of muskoxen between northern and southern Banks Island did not take place between their surveys. The large difference between the number of muskoxen estimated in 1980 and 1982 remains to be explained. Variables, such as survey methods and animal movements, may have affected population estimates and they require further study.

Muskox anti-predator behaviors

Historical hunting accounts

While studies have been conducted to evaluate the impact of industrial activity on muskox behavior (for example, Miller and Gunn 1979), muskox responses to machines (aircraft or snow vehicles of various types) do not provide appropriate analogs for inferring how animals would have reacted to Inuit hunters on Banks Island.

The few descriptions of Copper Inuit muskox hunting haye already been mentioned in Chapter Two. Barrenground muskox exploitation by both Dene and Inuit is reported in the late 19th century literature. A few of these hunting accounts are described here to elaborate on muskox response to predators.

Whitney et al. (1904:34) mention that muskoxen are very difficult to hunt on the Barrengrounds without the use of dogs. Presumably this is because the muskoxen spotted human predators and fled well before the hunters got within shooting distance. Russell (1896), who hunted muskoxen north of Great Slave Lake with the Dogrib, reports that the Dene would not even consider a muskox hunt without dogs. As soon as muskoxen were sighted, the dogs were unleashed. Once the herd was overtaken by the canids, the muskoxen formed a defensive circle and were described as easy prey for the hunters (Russell 1896:238).

Schwatka (1883:674-675) hunted with the Inuit near Hudson Bay in 1879-1880 and reported the following:

> The Eskimos with whom I was brought into contact never hunt the musk-oxen without a plentiful supply of well-trained dogs; for, with their help, the hunters are almost certain of securing the whole herd, unless the animals are apprised of the approach....When the flying herd has been brought to bay in their circle of defence by the dogs, the Eskimo hunters approach within five or six feet and make sure of every shot that is fired, as a wounded animal is somewhat dangerous, and extremely liable to stampede the herd. A band of these brutes when once stampeded are much harder to bring at bay the

> second time....When the circle of cattle is first approached, the hunters take care to dispatch first the active and aggressive bulls....as their members fall, one at a time, the muskoxen persist in their singular mode of defence....When but two are left, these with rumps together, will continue the unequal battle; and even the last "forlorn hope" will back up against the largest pile of his dead comrades....

Wildlife biologists tagging muskoxen in Greenland have also found that huskies are effective in reducing muskox flight distance, and keeping animals herded into defensive formations (B. Clausen, pers. comm. 1983). They discovered that two dogs were ideal for controlling herds, but that more dogs tended to cause "confusion" among the muskoxen and resulted in greater canine injury due to goring.

1982 field observations

Muskox behavioral responses to humans were observed first hand on many occasions during the 1982 field season around the Kuptana Site. Animals were often encountered at close distance while on foot surveys or evening hikes. This was due to the hilly topography which concealed humans and animals from one another until they were unknowingly in close proximity. Several descriptions which document variation in animal behaviors towards humans are condensed below from the writer's fieldnotes.

Four muskox bulls were sighted while hiking to Able Creek on the morning of June 25th. They were feeding apart from one another when first seen. Our party of four headed towards the creek bank to a place where we hoped that the creek was shallow enough to cross. The bulls spotted us and quickly grouped close together at the spot where we intended to make our crossing. Another crew member and I approached the herd to within 60 m. We waved our hands and shouted, hoping to frighten them from their position. They responded with gland-rubbing behavior (see Gray 1973:81) but did not retreat. We left the area, and the muskoxen went back to feeding.

On June 28th, late in the afternoon, four crew members including myself came upon a herd of 14 ruminating animals. Four calves were present. The muskoxen quickly rose to their feet and formed a defensive circle. The group maintained this posture even after we left the area and were more than .5 km away.

A herd of 17 animals containing only one calf was spotted about 2 km southwest of the Kuptana site late in the afternoon of July 3. One crew member and myself set out to census the herd and photograph it. The animals were approached by following a ridge which concealed us from their view. When we came over the ridge, we were 40-50 m distant from the herd, and above it. Most of the animals, except for two bulls, were lying down. The animals were startled by our presence, and quickly crowded into a line facing us once they were on their feet. Several individuals gland-rubbed. After a couple of minutes, one bull charged up the ridge (which was the only high ground in the surrounding area) in our direction. The rest of the herd followed his lead. The muskoxen reached the top of the ridge just as we reached the bottom on the opposite side. We continued back to the site, and the animals followed and watched us as they walked along a ridge paralleling our course. After several minutes, they disappeared from view.

Lastly, a herd of muskoxen was sighted about 2 km west of the Kuptana site basecamp on the evening of July 6th. One other individual and myself went to census them. The herd consisted of nine animals including one calf. Two bulls were engaged in "head butting" (see Gray 1973:79), and did not notice our approach. After we were spotted by the animals some 60 meters away, the entire herd fled at a full gallop and continued that pace for at least 2 km.

These observations show a much wider range of muskox responses to a predator than are indicated by historical accounts. They also demonstrate that in variable topographic situations it is possible to approach a muskox herd quite closely before being seen by the animals. Dogs may be primarily useful for narrowing the range of behavioral responses elicited from muskoxen when confronted by a potential predator. This would certainly facilitate the predictability and, therefore, the outcome of the hunt.

Summary

A number of conclusions about muskox biology and behavior relevant to the archaeological analysis of Copper Inuit muskox exploitation are derived from the above discussion. They are summarized in point form below.

1. Muskox behavior, physical characteristics, distribution and abundance on Banks Island prior to the arrival of Copper Inuit in the 19th century were probably quite similar to the contemporary situation.
2. Muskoxen are biologically more closely related to sheep and goats than they are to caribou.
3. Adult female muskoxen weigh less than males, and both sexes experience seasonal weight fluctuations.
4. Herd size, age composition, and sex ratio vary throughout the year in response to food availability and changes in animal social behavior. Average winter herd size is larger than the summer average, but large herds can occur during any season. Solitary animals and small, single-sex groups are most common during the summer.
5. Muskox density on northern Banks Island is quite high, and animals occupy the Thomsen and Parker river drainages year round.
6. Seasonal, large-scale movements have not been recorded in muskox populations. The animals are relatively sedentary when compared with other ungulates, such as caribou. Range requirements, however, may result in animal movements over short distances of up to 50 km.
7. Muskoxen spend much of their time feeding in sedge meadows that occur in lowland areas. The severity of winter snow conditions can force animals to seek alternative food resources, such as willows and grasses, on exposed ridges.

8. Calf production and the survival of both young and old animals is strongly influenced by winter food availability. Prolonged, deep, hard-packed snow cover can result in large winter die-offs and no calf production in the following spring. Therefore, sharp population declines are possible, and have been documented in a single year.
9. Muskoxen on northern Banks Island have been well-fed in recent years as evidenced by high calf production and population increase compared with animals on other Arctic islands.
10. Census data on the Banks Island muskox population may be inaccurate in that there are no satisfactory explanations for the huge increases and decreases in animal abundance recorded between 1972 and 1982. Inter-island migration may play a role.
11. Animal mortality is due to many factors including starvation and predation. Calf mortality resulting from wolf predation cannot be adequately evaluated but may be very important.
12. Muskox responses to predators is variable, and is influenced by topographic relief. Once animals have formed a defensive circle, it is a relatively easy task for a hunter to dispatch every individual. Dogs may be instrumental in reducing flight distance of frightened animals before they form a defensive circle.

IV. Food Utility Indices and Other Quantitative Measures

Introduction

As discussed in Chapter One, Binford (1978) used a maximization approach to guide his study of caribou and sheep use by contemporary Nunamiut. Binford did not assume that people consistently maximized their efforts; rather, he employed his food use models as a referent against which to compare Nunamiut variable subsistence practices. He constructed a set of scales, or utility indices purporting to measure the relative value of various foods (meat, marrow, and bone grease) associated with individual carcass parts. The three food utility indices were used to model Nunamiut food processing and consumption patterns in the zooarchaeological record. Similar indices for measuring relative variation in the utility of muskox anatomical parts are developed below. They are incorporated into models for examining Copper Inuit subsistence practices which are presented in Chapter Six.

Other quantitative measures are also discussed in this chapter. A maturity index is devised to measure relative age differences among muskox kill populations inferred from site osteological assemblages. The index is also used to examine differences in procurement strategies and to address Stefansson's extinction hypothesis.

Because the minimum number of individuals (MNI) estimation method is intimately involved in analyses of archaeological faunal materials, it is also considered in this chapter. It is argued that the specific derivation of the MNI is dependent on the kinds of questions being addressed with osteological information. Two counting methods are discussed, one for estimating the number of whole animals, and the other for deriving the number of anatomical parts from a bone assemblage.

Food utility indices

Although not specifically stated, the reason that Binford (1978) chose meat, marrow and bone grease as variables to construct food utility indices is probably because they are explicitly recognized as food resources by the Nunamiut. As was described in Chapter Two, the Copper Inuit also distinguished and used these foodstuffs, at least with respect to caribou.

Binford (1978) constructs three food utility indices by measuring the amount and/or quality of meat, marrow and bone grease affiliated with caribou and domestic sheep anatomical parts. For example, a caribou femur possesses more meat than a tibia and will therefore have greater relative value. The anatomical part containing the femur is assigned a meat index score reflecting this difference. Binford (1978) partitions an animal carcass into anatomical parts corresponding to individual skeletal elements or element portions (i.e. proximal, medial or distal). He (1978:39-45) documents that these parts roughly correspond to cognitive units elicited from informants regarding butchery practices and food preferences.

Data which are required to construct the indices are generally unavailable in the literature. For example, specific information is necessary concerning the weight of meat found on a femur compared to a humerus, or the volume of the tibia marrow cavity compared to that of the metatarsal. Binford collected this type of information for both caribou and sheep independently. His sample was small, consisting of a single, adult caribou, and one mature and one immature domestic sheep. However, he (1978:15-45) argues that the results were not significantly biased by sample size because index values for the two species are remarkably similar. What is not adequately demonstrated, however, is how age and sex differences, and seasonal variation in animal nutritional status might affect the results.

Binford's (1978) methods for constructing each food index will be described for the purpose of creating comparable indices for muskox anatomical parts. Many of the specific data for formulating the muskox indices could not be obtained, because it was impossible to acquire a fresh muskox carcass for study. However, it was noted in Chapter Three that this species is biologically closely related to sheep and, where appropriate, data on the latter are substituted in the muskox indices construction.

Binford (1978:28 and 35) demonstrates that caribou and sheep marrow and grease index values are remarkably alike. This is due to the observation that the marrow cavity volumes of anatomical parts are proportionally similar between the two species, even though the actual volumes of caribou bones are much larger than sheep bone volumes. A linear relationship between sheep and caribou bone volumes exhibits a high correlation (r=.90, p=.001) (The data for this statistic were obtained from Binford 1978:24, Table 1.6). Since the objective was to approximate muskox values for variables used to construct food utility indices, volumetric data which are not available for muskoxen are substituted with Binford's caribou information.

Construction of an approximated Meat Utility Index (MUI) for muskoxen

Binford (1978:19-23) constructed meat utility indices (MUI) for both sheep and caribou. Similarities and differences exist between the two species in the proportion of meat occurring with each anatomical part. For example, sheep appear to have proportionally more meat associated with the rib and sternum anatomical parts than do caribou (Binford 1978:23, Table 1.5). Variation in the relative meat value of anatomical parts was anticipated to exist among muskox, sheep and caribou as well.

Although a muskox carcass was not available for butchery, Hanbury's weights for anatomical segments of a bull muskox butchered on the Barrengrounds were presented in

Chapter Three (Table 3.2). These data are used in the construction of the muskox meat utility index, and are rearranged in Table 4.1 for direct comparison with Binford's (1978:18, Table 1.3) sheep and caribou information.

Personal observation of living muskoxen suggests that they are more massive in the forequarters than in the hindquarters. Hanbury's weight information support this suggestion. The front legs comprise 25.5% of the total weight of major anatomical segments (Table 4.1, part B), whereas the hindlegs only total 23.0%. Consequently, it is essential that the MUI reflect these differences in order to accurately measure the relative meat value of muskox anatomical parts.

In contrast, Binford's (1978:18) data indicate that caribou hindquarters are about 10% heavier than are their front legs. Sheep hind legs are only slightly heavier than their forequarters. Additionally, muskox axial parts equal 51.5% of the total weight of major anatomical segments. Sheep axial parts also compose slightly more than half the total weight (carcass exclusive of skin, blood, and viscera), however, caribou axial parts represent only 46.6% of the total weight of major anatomical segments.

The initial step in constructing Binford's MUI for muskoxen was to obtain a gross weight for each anatomical part (a body portion usually containing one skeletal element; exceptions include portions of the axial anatomical segment). Unfortunately, Hanbury did not butcher muskox

Table 4.1

Comparative Body Proportions for Muskox[1]

A. General anatomical categories	Weight (kg)	Percentage
blood	4.5	1.7
skin	17.2	6.5
organs	66.2	25.2
meat, fat, bone	169.2	64.4
extras	5.4	2.1
total	262.6	99.9
B. Major anatomical segments		
axial parts	87.1	51.5
front legs	43.1	25.5
hind legs	39.0	23.0
total	169.2	100.0

[1] Derived from weight data presented in Table 3.1.

limbs into anatomical parts, but instead weighed them as whole segments. This made it necessary to reconstruct the gross weight of muskox appendicular anatomical parts.

Binford (1978:16, Table 1.1) provides gross weights for sheep and caribou anatomical parts. These weights were divided by the total weight of the respective anatomical segment (front or rear leg) to derive a relative percentage. Percentages for Binford's sheep and caribou front and hind legs presented in terms of relevant osteological element(s) appear in Table 4.2 (cols. 1-3). The calculations show that a regular weight relationship exists among various appendicular anatomical parts for the caribou and two sheep studied by Binford. For example, the anatomical part containing the scapula is consistently the heaviest portion of the front leg. Its counterpart in the hindlimb is the femur which is approximately 67% of the total hind leg weight.

No published data exist to document whether these weight relationships are relatively constant among medium size artiodactyls. However, anatomical part weight data collected from an adult male mountain goat (*Oreamnos americanus*) butchered by Jean Hourston-Wright (Department of Anthropology, University of Alberta) and the author suggest its plausibility. The mountain goat anatomical part containing the scapula was the heaviest in the front leg, composing 39.7% of the total weight. The anatomical part containing the femur composed 71.5% of the total rear leg

Table 4.2

Gross Weight of Anatomical Part/Total Weight of Limb[1]

Anatomical Part	Sheep (6 mo) (1)	Sheep (90 mo) (2)	Caribou (48 mo) (3)	Average (4)
A. Front Leg				
scapula	.42	.42	.44	.427
humerus	.29	.29	.30	.293
radio-cubitus	.16	.16	.17	.163
metacarpal	.07	.07	.07	.070
phalanges	.05	.05	.03	.043
total	.99	.99	1.01	.996
B. Hind Leg				
femur	.67	.66	.69	.673
tibia+tarsals	.19	.22	.20	.203
metatarsal	.10	.07	.10	.090
phalanges	.04	.04	.02	.033
total	1.00	.99	1.01	.999

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[1] Data for calculations were derived from Binford (1978:16, Table 1.1).

weight. Slight differences between Binford's weight proportions for other parts and those of the goat arose from uncertainties as to whether or not Binford weighed the carpals with the metacarpal, or the hoof cuticles with the phalanges. In order to maintain comparability, a weight percentage for each muskox appendicular anatomical part was approximated by averaging Binford's sheep and caribou data (Table 4.2, col. 4). The limb weights collected by Hanbury were then multiplied by the average anatomical part weight percentages to obtain reconstructed gross weights of individual muskox limb portions (Table 4.3, col. 1).

Following Binford's method, the next step to construct an MUI was to divide the gross weight of each muskox appendicular anatomical part by the total weight for the major anatomical segments (appendicular and axial parts) which is 169.2 kg (see Table 4.1). This procedure was conducted to derive the weight of each anatomical part relative to the weight of the entire carcass (excluding skin, blood and organs). The resultant value for each anatomical part was multiplied by 100 in order to yield the weight percentages shown in Table 4.3, col. 2. They are directly comparable with the percentage data presented by Binford (1978:20) in his Table 1.4, cols. 1-3 for sheep and caribou.

Unfortunately, the regularity in the weight percentage relationship among sheep and caribou limb bones is not apparent among their axial anatomical parts. Consequently,

Table 4.3

Variables Required for Constructing a Muskox Meat Utility Index (Appendicular Parts)

Anatomical Part	Gross Weight (kg) (1)	$\frac{\text{Gross Weight of Body Part}}{\text{weight anatomical segments}} \times (100)$ (2)	$\frac{\text{100-dry bone weight}}{\text{gross weight}}$[1] (3)
scapula	9.20	5.44	.94
humerus	6.31	3.73	.86
radio-cubitus	3.51	2.07	.78
metacarpal	1.51	.89	.66
phalanges	.93	.60 (49)[2]	.65
femur	13.12	7.76	.94
tiba+tarsals	3.96	2.34	.81
metatarsal	1.76	1.04	.67
phalanges	.64	.38 (.49)	.65

[1] Average derived from Binford (1978:20, Table 1.4,cols. 4-6).

[2] Average for front and hind foot.

no weight percentage constants could be calculated for estimating the weights of individual anatomical parts making up the muskox axial segment. This problem will be addressed later.

Since the objective of constructing an MUI is to determine the amount of usable meat per anatomical part, the next operation requires subtracting the weight of dry, nonusable bone from anatomical part gross weights. Binford (1978:19) accomplished this task by subtracting dry weights of sheep and caribou bone elements from 100 and then dividing the remainder by the gross weight of each anatomical part (refer to Binford 1978:20, Table 1.4, cols. 4-6).

Dry bone weights for Hanbury's muskoxen were not available. However, sheep and caribou bone weights demonstrate that weight percentages among elements are similar between species. This may be due to structural similarities of artiodactyl appendicular skeletons (for instance, see Alexander et al. 1979). Further support for this hypothesis is derived from the observation that there is a strong correspondence in the weight percentage of individual dry bones to the total dry bone leg weight among several artiodactyl species (Table 4.4). Therefore, values derived from averaging cols. 4-6 in Binford's Table 1.4 (1978:20) were selected as reasonable approximations of the percent of usable gross weight for muskox appendicular parts (Table 4.3, col. 3). The muskox MUI for appendicular

Table 4.4

Appendicular Dry Bone Weights for Selected Artiodactyl Skeletons (element dry weight/total limb dry weight)[1,2]

Anatomical Part	Sheep (6mo) (1)	Sheep (90mo) (2)	Caribou (48mo) (3)	Big Horn Sheep (adult fe) (4)	Goat (adult) (5)	Bison (adult ma) (6)	Bison (adult fe) (7)	Muskox (adult)[3] (8)	Average (9)
A. Front Leg									
scapula	.16	.22	.17	.17	.21	.26	.19	.21	.20
humerus	.31	.27	.29	.31	.29	.29	.31	.30	.30
radio-cubitis	.25	.25	.27	.27	.28	.25	.24	.27	.26
metacarpal	.18	.15	.18	.16	.13	.13	.18	.16	.16
phalanges	.09	.11	.09	.09	.09	.07	.08	.07	.09
total	.99	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01
B. Hind Leg									
femur	.37	.36	.31	.30	.31	.37	.37	.39	.35
tibia[4]	.29	.34	.34	.36	.33	.29	.28	.29	.32
metatarsal + tarsals	.26	.18	.27	.27	.26	.26	.27	.26	.25
phalanges	.08	.12	.08	.07	.09	.09	.08	.07	.09
total	1.00	1.00	1.00	1.00	.99	1.01	1.00	1.01	1.01

1. Data for calculations in columns 1-3 were derived from Binford (1979:16, Table 1.1, column 4-6).
2. Data for calculations in columns 4-8 were derived by weighing prepared skeletons in the Department of Anthropology's osteological collection, University of Alberta, Edmonton.
3. Terminal phalanges were missing; it is not known if all bones were from the same individual.
4. Binford (1978:16, Table 1.1) sums the dry weight of the tarsals and the tibia. However, my frequencies were very different from his unless the tarsals were included with the metatarsal.

anatomical parts was produced by multiplying together columns 2 and 3 in Table 4.3. The resultant appendicular anatomical part MUI approximated for muskoxen appear in Table 4.5, col.1.

Information was not available to produce a meat index specific to muskox axial parts. The biological similarities between sheep and muskox have already been discussed. Therefore, Binford's sheep axial anatomical part meat values were substituted to approximate values for muskox axial parts.

Binford's meat utility index for sheep (1978:23, Table 1.5, col. 1) requires some explanation. Binford states that the sheep index is based on the mean for the six and 90 month old sheep, with two exceptions. He (1978:21) used the index value for the thoracic vertebrae from the younger animal, and the lumbar index value from the older sheep rather than the mean values for each part. These values were selected to offset the differences resulting from variation in butchery techniques. Since Binford's goal was to generate a sheep MUI comparable to the caribou one, he chose values for the sheep thoracic and lumbar anatomical parts which were butchered in a manner similar to the caribou. The same rationale was adopted here so that the muskox MUI would be comparable to Binford's sheep MUI.

In addition, because the ranges of the meat utility indices for each species studied by Binford were different, he (1978:20) standardized them on a scale from 1-100 to

Table 4.5

Approximated Muskox Meat Utility Index[1]

Anatomical Part	Meat Utility Index (1)	Standardized Meat Utility Index (2)
cranium	2.29	24.52 (12.26)
mandible (with tongue)	3.89	41.65
mandible (without tongue)	1.26	13.4
atlas-axis	1.73	18.52
cervical	5.14	55.03
thoracic	4.69	50.21
lumbar	3.30	35.33
pelvis + sacrum	7.60	81.37
rib	9.34	100.00
sternum	8.29	88.88
scapula	5.11	54.71
humerus	3.21	34.37
radius	1.60	17.13
carpals	.58	6.21
metacarpals	.58	6.21
femur	7.29	78.05
tibia +	1.90	20.34
tarsals	.70	7.49
metatarsals	.70	7.49
foot	.31	3.32

1. Axial indices were derived from the average of cols. 7 and 8 (Binford 1978:21, Table 1.4). Appendicular indices were derived from multiplying cols. 2 and 3 in Table 5.3.

facilitate comparison between species. Standardization was accomplished by dividing each anatomical part MUI by the largest index value (for example, the femur produced the largest caribou MUI of 10.33, Binford 1978:21), and then multiplying the result by 100. This procedure was also followed in the construction of all three muskox food utility indices.

In order to obtain an MUI for muskox axial anatomical parts, it was necessary to average the MUI, not the standardized MUI, for sheep axial parts. The average values for sheep axial portions (which are used as approximations for muskox values) and the values obtained for muskox appendicular parts are shown in Table 4.5, col. 1. The standardized muskox MUI was generated by dividing all values by the largest anatomical part value (in this case, the rib MUI which is 9.34), and then multiplying by 100 (Table 5.5, col. 2).

Binford (1978:23) used the metacarpal and metatarsal indices for the carpals and tarsals, respectively. The same procedure was followed here for muskoxen, although it is recognized that his decision appears to have been an arbitrary one, and that these values are perhaps inflated for these particular anatomical parts. He also averaged the value for the front and hind foot, and this procedure has been followed as well.

Lastly, Binford (1978:23) arbitrarily halved the skull index for both sheep and caribou suggesting that the smaller values were more "realistic" with respect to meat utility. The same was done for the muskox skull meat index value and it is suggested that it should be even less than half, because of the massive boney structure associated with the horns. Three complete adult male skulls collected from Banks Island archaeological sites were weighed, and they averaged 8.2 kg. The average weight derived from two female specimens was 2.6 kg. Allen (1913:182, Table 3) lists an average weight of 5.5 kg. for three adult male skulls, and an average weight of 2.6 kg. for five female skulls. His skull sample was collected from Bache Peninsula and Melville Island. Both samples of skull weights show that male skulls are at least twice as heavy as female skulls. It is not known why the male skulls from Banks Island are so much heavier than those reported from Melville Island.

A comparison of the approximated muskox MUI and the MUI's for sheep and caribou (see Binford 1978:23, Table 1.5; and Table 4.5, this study) demonstrates that the former takes into account weight differences in the front limb. Muskox anatomical parts containing the scapula, humerus and radius all have higher MUI values than Binford assigned to the same parts in sheep and caribou. Muskox front and hind legs are more equal in their meat value than are the same parts from the other two species. The significance of this observation will become apparent in the analysis of archaeological muskox remains presented in Chapter Six.

Construction of an approximated Marrow Index (MI) for muskoxen

Bone marrow is another food resource obtained from animal carcasses for which utilization is documented among hunter-gatherers. The Nunamiut process sheep and caribou bones for marrow, and Binford (1978:27, Table 1.9) constructed an index (MI) to quantify its utilization. A similar index, approximated for muskoxen, is presented here (see Table 4.6, col. 4).

Binford (1978) observed that the Nunamiut select marrow bones on the basis of marrow quality and quantity. He (1978:24, Table 1.6) measured quality as the percentage of oleic acid (grease) in marrow from each sheep and caribou anatomical part. Quantity was evaluated in terms of "efficiency" - the amount of marrow returned per unit of work invested (1978:25). Interestingly, Binford concluded that processing time did not vary much with anatomical part size. Therefore, efficiency actually measures variation in the marrow cavity volume.

Quality and efficiency values for sheep and caribou were transformed by Binford (1978:25) before they were multiplied together to produce a marrow index. Oleic acid proportions were squared, and then divided by 100 to depress low oleic acid values (obtained by chemical assay) which were probably not as precisely discriminated by Nunamiut.

Next, Binford (1978:26) calculated the square root of anatomical part efficiency values. He argued that this

Table 4.6

Construction of Approximated Muskox Marrow Index

Anatomical Part	Efficiency (caribou) (1)	Grease (sheep) (2)	Marrow Index (3)	Standardized Marrow Index (4)
skull	-	-	1.0	1.0
mandible	1.19	10.89	12.96	9.23
atlas	-	-	1.0	1.0
axis	-	-	1.0	1.0
cervical vertebra	-	-	1.0	1.0
thoracic vertebra	-	-	1.0	1.0
lumbar vertebra	-	-	1.0	1.0
pelvis	.88	13.69	12.05	8.58
rib	-	-	1.0	1.0
sternum	-	-	1.0	1.0
scapula	.81	10.89	8.82	6.28
proximal humerus	2.08	16.00	33.28	23.71
distal humerus	2.08	23.04	47.92	34.14
proximal radius	2.09	23.04	48.15	34.30
distal radius	2.09	44.89	93.82	66.84
carpal	-	-	1.0	1.0
proximal metacarpal	1.63	53.29	86.86	61.88
distal metacarpal	1.63	60.84	99.17	70.65
proximal femur	2.46	19.36	47.63	33.93
distal femur	2.46	28.09	69.10	49.23
proximal tibia	2.68	29.16	78.15	55.68
distal tibia	2.68	50.41	135.10	96.25
tarsal	-	-	1.0	1.0
astragulus	-	-	1.0	1.0
calcaneus	.63	50.41	31.76	22.63
proximal metatarsal	2.43	50.41	122.50	87.28
distal metatarsal	2.43	57.76	140.36	100.00
first phalanx	.73	57.76	42.16	30.04
second phalanx	.51	60.84	31.03	22.11
third phalanx	-	-	1.0	1.0

transformation was made to accomodate informant biases favoring grease quality, and recognition of a threshold below which effort expenditure exceeded marrow returned. Once the quality and efficiency values were transformed, they were multiplied together, divided by the largest anatomical part MI value, and then multiplied by 100 to produce a standardized MI.

Since no fresh muskox bones were available for analysis, an approximated MI was constructed with sheep and caribou data collected by Binford. In that muskox bone volumes are greater than those of sheep, their MI values were produced by multiplying together the modified caribou efficiency values (a volumetric measure) with the transformed sheep oleic acid values (see Table 4.6, cols. 1-3). The procedure was followed in order to emphasize the size similarities between muskoxen and caribou, and to take into account the biological affinities between muskoxen and sheep by substituting sheep oleic acid values. It is argued that the resultant index more closely approximates marrow values for muskox bones than either sheep or caribou indices do individually. The approximated muskox marrow index was standardized (Table 4.6, col.4) by dividing all anatomical part MI by 140.36 (the largest MI which was obtained from the distal metatarsal, Table 4.6, col.3).

Construction of an approximated Bone Grease Index (GI) for muskoxen

Bone grease is defined as the fat and grease contained within bone tissue (Binford 1978:32). It is obtained by pulverizing and then boiling bone (see Leechman 1951; Vehik 1977). The Copper Inuit made bone grease and valued it highly as a food resource (see Chapter Two).

The Nunamiut distinguish two kinds of grease: yellow and white (Binford 1978:32). Yellow grease is associated more or less with the axial skeleton, and was burned in lamps. White grease occurs in greatest amounts in the ends of long bones, and it is a rich food source. According to Binford (1978:32), these two grease types are never stored together by the Nunamiut. Differentiation of them is probably related to their oleic acid content, which in turn influences their respective melting points.

Binford (1978:32) constructs bone grease indices (GI) for sheep and caribou on the basis of three criteria: a) quality of rendered grease, b) bone density and c) part size. Sheep and caribou GI along with accompanying data are presented in his Table 1.11 (1978:33). He shows that a positive, linear relationship exists (r=.96) between the indices of the two species (1978:35), but that quantitative differences in grease availability between the species as exhibited by part volumes is present. Binford (1978:35) suggests that grease quantity may increase logarithmically with body size.

For reasons similar to those used in constructing a muskox marrow index, the approximated muskox GI was calculated with the sheep grease and bone density anatomical part values, and the caribou part volumes. The relevant sheep and caribou data, and approximated standardized GI for muskoxen, are presented in Table 4.7.

Because the Nunamiut distinguish two kinds of grease, Binford (see 1978:34, Table 1.12) also separated his grease index into two scales. The division was based on bone elements possessing grease values with less than or more than 40% oleic acid. They correspond to the percentages of oleic acid occurring in the bones of the axial and appendicular skeleton, respectively.

Binford (1978:34) assigns a value of 1.0 to axial parts in the white grease index, and a value of 1.0 to appendicular parts in the yellow grease index. The same procedures used by Binford to make sheep and caribou grease indices were employed to construct the approximated muskox GI. The resultant muskox white and yellow grease indices appear in Table 4.8.

In summary then, three approximated food utility indices were constructed for muskox anatomical parts. Data on sheep and caribou (which were obtained by Binford) were substituted in the construction of the muskox indices in instances where relevant muskox information were not available. Weight information presented by Hanbury on a piece butchered, bull muskox was used to generate a meat utility index. The approximated muskox marrow index was constructed with information about the oleic acid content of

Table 4.7

Construction of Approximated Muskox Bone Grease Index

Anatomical Part	(1) .01(GV)/D[1] (sheep)	(2) .01(V)[2] (caribou)	(3) COL 1 x COL 2	(4) (COL 3/22.29) x 100 Standardized Grease Index
mandible	2.75	.61	1.68	7.54
atlas	2.94	.48	1.41	6.33
axis	3.17	.45	1.43	6.42
cervical vertebra	6.61	.41	2.71	12.16
thoracic vertebra	8.43	.24	2.02	9.06
lumbar vertebra	8.02	.31	2.49	11.17
pelvis	7.57	.69	5.22	23.42
rib	9.46	.14	1.32	5.92
sternum	18.01	.29	5.22	23.42
scapula	4.97	.21	1.04	4.67
proximal humerus	17.48	.87	15.21	68.24
distal humerus	9.30	.52	4.84	21.71
proximal radius	12.82	.46	5.90	26.47
distal radius	28.65	.21	6.02	27.01
carpal	30.89	.20	6.18	27.73
proximal metacarpal	39.87	.08	3.19	14.31
distal metacarpal	45.07	.18	8.11	36.38
proximal femur	11.05	.38	4.20	18.84
distal femur	25.92	.86	22.29	100.00
proximal tibia	21.09	.60	12.65	56.75
distal tibia[3]	31.53	.16	5.04	22.61
tarsal	34.60	.16	5.54	24.84
astragulus	34.83	.17	5.92	26.56
calcaneus	35.32	.26	9.18	41.18
proximal metatarsal	38.12	.10	3.81	17.09
distal metatarsal	45.26	.19	8.60	38.58
first phalanx	78.01	.11	8.58	38.49
second phalanx	80.00	.07	5.60	25.12
third phalanx	70.21	.04	2.81	12.61

1. Binford (1978:33, Table 1.11, col. 4) where GV=grease value and D=bone density.

2. Binford (1978:33, Table 1.11, col. 3) where V=volume.

3. Binford lists 36.50, however, recalculation shows correct value to be 31.53.

Table 4.8

Approximated Muskox White and Yellow Grease Indices

Anatomical Part	White Grease (1)	Yellow Grease (2)
mandible	1.00	38.18
atlas	1.00	27.01
axis	1.00	27.39
cervical vertebra	1.00	51.92
thoracic vertebra	1.00	38.70
lumbar vertebra	1.00	47.99
pelvis	1.00	100.00
rib	1.00	25.29
sternum	1.00	100.00
scapula	4.97	1.00
proximal humerus	17.48	1.00
distal humerus	9.30	1.00
proximal radius	12.82	1.00
distal radius	28.65	1.00
carpal	30.89	1.00
proximal metacarpal	39.87	1.00
distal metacarpal	45.07	1.00
proximal femur	11.05	1.00
distal femur	25.92	1.00
proximal tibia	21.09	1.00
distal tibia	31.53	1.00
tarsal	34.60	1.00
astragulus	34.83	1.00
calcaneus	35.32	1.00
proximal metatarsal	38.12	1.00
distal metatarsal	45.26	1.00
first phalanx	78.01	1.00
second phalanx	80.00	1.00
third phalanx	70.21	1.00

sheep marrow, and volumetric data concerning caribou bone marrow cavities. Because muskoxen are biologically more closely related to sheep than to caribou, the oleic acid values for sheep anatomical parts were used to approximate muskox values. However, since caribou and muskoxen are larger than sheep, caribou bone volume measures rather than those for sheep were assumed to better approximate the volumes of muskox bones. Similar rationales in substituting sheep and caribou data for missing muskox information were employed in the calculation of an approximated grease index.

Construction of the Maturity Index (MATI)

Another research objective was to investigate Copper Inuit strategies of muskox procurement. This was particularly important for evaluating the role of Inuit hunters in the hypothesized extermination of the Banks Island muskox population. It was necessary to compare the age and sex composition of the harvested population with that of living muskoxen on northern Banks Island. Documenting purposeful, selective animal procurement by prehistoric hunters with zooarchaeological data is a difficult task. (see Wilkinson 1976). In addition, this issue cannot be satisfactorily addressed without reference to seasonal variation in animal herd structure and season(s) of exploitation by hunters. These two topics will be considered in Chapter Six. The method used to analyze the archaeological data regarding age structure is described and discussed below.

Standard approaches to aging wild animals are based upon knowledge of the time of tooth eruption and rate of tooth wear, and analysis of dental annuli (for an excellent review of the latter, see Grue and Jensen 1979). Another method involves the interpretation of epiphyseal fusion data (see Silver 1969). It is particularly an applicable technique when maxillary or dentary material are not equally represented among archaeological sites or when post-cranial remains are more abundant. The age at which epiphyseal caps bond to their diaphyses varies within, as well as among species. Zooarchaeological post-cranial specimens can be aged when the sequence of fusion has been related to chronological age for the species in question. The correlation between the sequence of fusion and animal age has only been determined for a few mammalian species, and most of these are domesticates. Lewall and Cowan (1963) provide substantial documentation for the sequence in the long bones of black-tailed deer (*Odocoileus hemionus*). These researchers worked with a collection of 34 male and female skeletons of known age. Although there is an orderly sequence of epiphyseal closure, it varies between males and females, and the rate is strongly influenced by the individual's nutritional state. In male deer, the last long bone epiphysis to fuse is that associated with the distal femur. However, the proximal humeral epiphysis fuses last in females. The sequence and rate of fusion among healthy individuals of both sexes is similar up until the age of 29 months. The proximal radius is the first long bone to fuse in both male and female black-tailed deer. Long bone fusion occurs next in the distal humerus, and is followed by the distal tibia and then the proximal femur. The sequence differs between the sexes after fusion in the proximal femur. For example, in male deer, the last epiphysis to fuse is that associated with the distal femur; it is the proximal humerus in females. A recent study of epiphyseal closure in white-tailed deer (*Odocoileus virginianus*) skeletons also duplicates this sequence in the long bones (Purdue 1983).

An investigation of epiphyseal closure in feral and domesticated goats is reported by Noddle (1974:195-204) who documents that the age of fusion varies with respect to sex and animal breed. The first four sites of long bone epiphyseal closure in the goat, however, correspond to that described for black-tailed deer. Noddle (1974:195) also notes that the sequence and rate of fusion are probably quite similar for both goats and sheep.

Unfortunately, no data on the sequence and rate of fusion in muskox limb bones are present in the literature. Since the proximal radius is the first long bone to fuse in the ungulates which have been studied, including close relatives of the muskox, it is probably the first element portion to fuse in muskoxen. The entire sequence of muskox long bone fusion may be the same as reported for sheep and goats but it must await confirmation from studies in progress. Thirteen muskox calves were captured on Banks Island in May 1982. The seven males and six females were flown to the Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon (Anonymous, 1982). Basic biological information is being recorded on the animals regularly. As they mature, data on the sequence and rate of bone fusion will be compiled (Peter Flood, pers. comm. 1983). At present, it has been noted that all muskox long bones remain unfused up until at least ten months of age.

Hypothetically then, when no unfused proximal radii are found at archaeological site A but some occur at site B, it is possible to roughly measure relative differences in age groups between the site assemblages. At site B, there is a subset of individuals which must necessarily be younger than any identified at the other site. This subset represents the youngest population of muskoxen which can be identified in the osteological sample.

Several possible problems are involved in making conclusions like this one. They are outlined by Watson (1978:97), and are reviewed here with respect to the Banks Island zooarchaeological material. First, differential destruction to fused and unfused bone elements due to natural and cultural processes may occur. Weathering can cause bones of immature animals to decompose faster than those of adults. Excellent preservation conditions on Banks Island indicate that natural destruction attributed to agencies such as weathering, would not bias the presence of fused and unfused long bones (see Chapter Five).

Differential bone destruction, due to cultural activity such as tool manufacture or bone grease production, can also occur. During the nineteenth century, bone implements were not commonly made on Banks Island. Almost all implements were manufactured out of antler, wood, and exotic materials obtained from the the H.M.S. Investigator and/or its cache in Mercy Bay (Cole-Will 1984). Though the destruction of bone ends to obtain grease may have varied between fused and unfused elements, there is no way in which to document it. Bone selection for grease extraction was probably more dependent upon differential grease quality and quantity among elements rather than on the state of bone fusion. In the Copper Inuit sites studied, all long bones, except those of very young muskox calves, were broken for marrow extraction.

Biased recovery and sampling error must be taken into consideration as well. Based on discussion to be presented in the next chapter, there is no reason to suspect that bones of young muskoxen were observed or recorded any differently than those of older animals. Sampled site areas are also quite large, exceeding 50 percent in every instance.

Finally, there may be some variation in the exact timing of long bone fusion, and it will limit precision in age estimation. The sequence and rate of long bone fusion is all but unknown in muskoxen, and therefore, only a general interpretation of physeal data is possible.

Two correlations which would be useful to know are at what point in the fusion sequence do muskox become reproductive, and if it varies between males and females. This is essential information for establishing ratios between the number of breeding and non-breeding animals removed from the Banks Island muskox population. With these data, the effects of hunting practices on the population could be modelled, and propositions concerning muskox extinction by 19th Century Copper Inuit on Banks Island could then be closely examined.

Since the fusion sequence for muskoxen is unknown, another measure of animal maturity was established. The maturity index (MATI) is constructed using methods described by Lewall and Cowan (1963:632) for black-tailed deer. These researchers assigned a value ranging from 0 to 3 to each major fusion site in long bones. The assigned value depended upon the degree of fusion. Epiphyses which separated during preparation of the skeleton were assigned a value of "0". Bones in which complete fusion had occurred were scored "3". Scores for each bone were summed to produce an individual total. The total was then compared with the known age and sex of each skeleton. The older the animal, the higher the total of summed closure scores.

Some variation in the fusion sequence exists between males and females, however, there is a strong correspondence between the two. By determining the index value, it is possible to accurately estimate black-tailed deer age, providing that individuals have not been subjected to nutritional stress or disease.

The degree of epiphyseal closure in muskox bones from the archaeological sites was not discriminated as precisely as in Lewall and Cowan's (1963) study. Epiphyseal caps which were completely separated or easily removed from their diaphyses were assigned a value of "1" (open). Specimens in which fusion had taken place such that the epiphysis could not be removed from the diaphysis were scored "2" (closed). Based on the degree of closure in the four major long bones: humerus, radius, femur and tibia, an MATI of 8 indicates the least mature individual (all 8 major fusion sites were open), and an index of 16 is diagnostic of the most mature individual (all 8 major sites of closure were fused) in the assemblage.

Since bones of individual animals could not be discriminated on the archaeological sites, the maturity index can only be used to obtain a measure of average age within the kill assemblage. The score is used to compare similarities and differences between sites, and must be interpreted with caution. A maturity index at either end of the scale does indicate a young or old animal population. However, an MATI between 8 and 16 represents a population of animals whose age has been averaged. It cannot, with one exception, represent the proportions of different age groups within the kill assemblage. The exceptional case is that unfused proximal radii at a site indicate that there is a group of muskoxen whose MATI is 8. The percentage of these bones is subtracted from the sample statistic, and a new MATI is recalculated for the remaining population. The resulting index for the subpopulation can then be compared with those from other sites.

In order to construct the MATI, the MNI based on the number of closed and open long bone ends is first determined. The percentage of closed and open epiphyses is then calculated for each long bone portion. Each percentage figure is multiplied by its respective closure value (1 or 2), and totals are calculated for all eight bone portions with the same value. The totals are summed and divided by 100 to produce a population maturity index. Individual site data concerning muskox minimum number of individuals are presented in Chapter Six.

Discussion of the minimum number of individuals (MNI) estimation method

The final quantitative measure for consideration in this chapter is the minimum number of individuals (MNI) estimation method. It was first proposed by White (1953b), and has been used in the analysis and reconstruction of a variety of prehistoric subsistence and settlement activities. The method has been the subject of considerable debate concerning not only its formulation, but also its correct application (see for example, Casteel 1974, 1977; Gilbert and Singer 1982; Grayson 1978, 1979; and Morlan 1983).

A major controversy surrounding the use of the MNI method involves the interpretation of whole animal counts. An untenable assumption related to its use is that entire animal carcasses were processed and consumed in discrete locations. An example which implicitly incorporates this assumption will illustrate the problem arising from its acceptance. Reconstruction of human population size and/or length of occupation at a prehistoric campsite has frequently been attempted with zooarchaeological analysis using the MNI method (for example, see Spiess 1979). Suppose that a proximal metatarsal of an adult caribou was uncovered at a small archaeological site. The MNI estimate for this arctiodactyl would obviously be one, and the amount of available food from this individual could weigh approximately 222 pounds (Binford 1978:136). Binford (1978:136) has determined that the average daily consumption of meat by an adult human (Nunamiut) is 2.63 pounds. Therefore, the single caribou would have provided about 84 days of food for one person. Various alternative interpretations of the 84 person-days of food are possible. They are dependent upon knowledge of the size of the consumer population and site function. One human may have consumed meat and other usable food items from the caribou carcass over a period of 84 days, or 84 people may have consumed the carcass in a period as brief as a single day! Either conclusion is improbable, because few ethnographically documented hunter-gatherer activities result in the creation of such sites.

If the site in which the caribou metatarsal was unearthed had been a hunting stand, at least two explanations exist for the bone's presence. First, the successful hunter may have removed the metatarsal from the caribou kill in order to 'snack' on marrow before transporting the rest of the carcass back to camp. Second, the bone may have been removed from cached food in camp, and carried to the hunting stand for a 'snack'. Each scenario has been documented among Nunamiut caribou hunters by Binford (1978). In both explanations the anatomical part, and not the whole carcass, is the appropriate unit for study.

Based on the problems inherent with the whole animal counting method for reconstructing subsistence activitites, Binford (1978:69) asserts that the MNI method should be restricted to estimating the number of individual bone elements for the purposes of relative comparison. The method is especially appropriate for analyzing large, well preserved faunal samples like those obtained from Banks Island Copper Inuit archaeological sites. Binford's (1978:69-72) MNI counting procedures are reviewed here, since the analysis of muskox faunal remains discussed in Chapter Six are in part dependent upon them.

Binford (1978:70) reports that contemporary Nunamiut hunters do not discriminate between sides when butchering a caribou. That is to say, left and right anatomical parts have an equal opportunity for being transported to the residential site. However, he does indicate that anatomical parts of differing sides may be transported to different areas, and concludes that the MNI should be obtained by dividing the total number of elements which are present in the body. Fractional MNI often result by using this method, and this situation may leave some researchers uncomfortable. Binford defends this unique approach by arguing that estimates of meat yield are greatly inflated when the MNI calculation is derived from the side of the bone element yielding the largest number. This is because one of his concerns is with documenting the amount of food which is available to the consumer population at a specific location. Binford observed the differential use of caribou and sheep carcasses by Nunamiut over space and through time, and thus he was not interested in hypothesizing how much food was available from whole animals. He employs similar arguments to justify why animal bones were not segregated by age.

Implicit in the use of the anatomical part counting method are the assumptions that sampling strategy is representative, and that taphonomic processes have not resulted in the removal or destruction of zooarchaeological material from the site prior to fieldwork. Data concerning Copper Inuit sites which are relevant to these topics are addressed in the next chapter.

The approach advocated by Binford for counting MNI seems reasonable for zooarchaeological research focused exclusively on reconstructing site specific subsistence activities. However, this is not the exclusive objective of this study. Much of the controversy surrounding the application of the MNI method has resulted from a failure to recognize that different counting methods may be required to research different problems. Binford's MNI estimation method is appropriate for examining site specific subsistence activities and it is adopted here for that purpose. However, it possesses no utility for addressing questions regarding the number and ages of animals harvested. Caribou or muskoxen are dispatched as whole animals. Obviously, if 7 right femora and 12 left femora are counted in a sample of faunal remains, at least 12 (not 9.5) animals must have been killed. Therefore, for the purposes of reconstructing animal procurement strategies, whole animal counts based on anatomical side and age information must also be calculated.

V. Data Collection: The Copper Inuit Sites and Methodological Considerations

Introduction

Site selection criteria and data collection methods are reviewed in this chapter. Selection was based on criteria used by Dr. Clifford Hickey in locating sites appropriate for reconstructing and explaining 19th century Copper Inuit culture in the west-central Canadian Arctic. The three sites chosen by Hickey for intensive archaeological investigation, Haogak (PhPo-3), Nasogaluak (PgPw-3) and Kuptana (PjRa-18), (see Figure 5.1) all possessed characteristics amenable for conducting zooarchaeological analyses. The general criteria which made these sites suitable for studying Copper Inuit subsistence activities involving muskox procurement and use are presented first. They are followed by a brief description of each site, and then a detailed discussion of data collection methods.

Site selection

Five criteria were used to select sites that were appropriate for investigation. They included: identifying sites occupied during the 19th century; locating well preserved osteological assemblages; finding sites in which little excavation was required to expose remains; choosing sites in differing environments for comparative purposes; and assessing sites based upon logistical considerations.

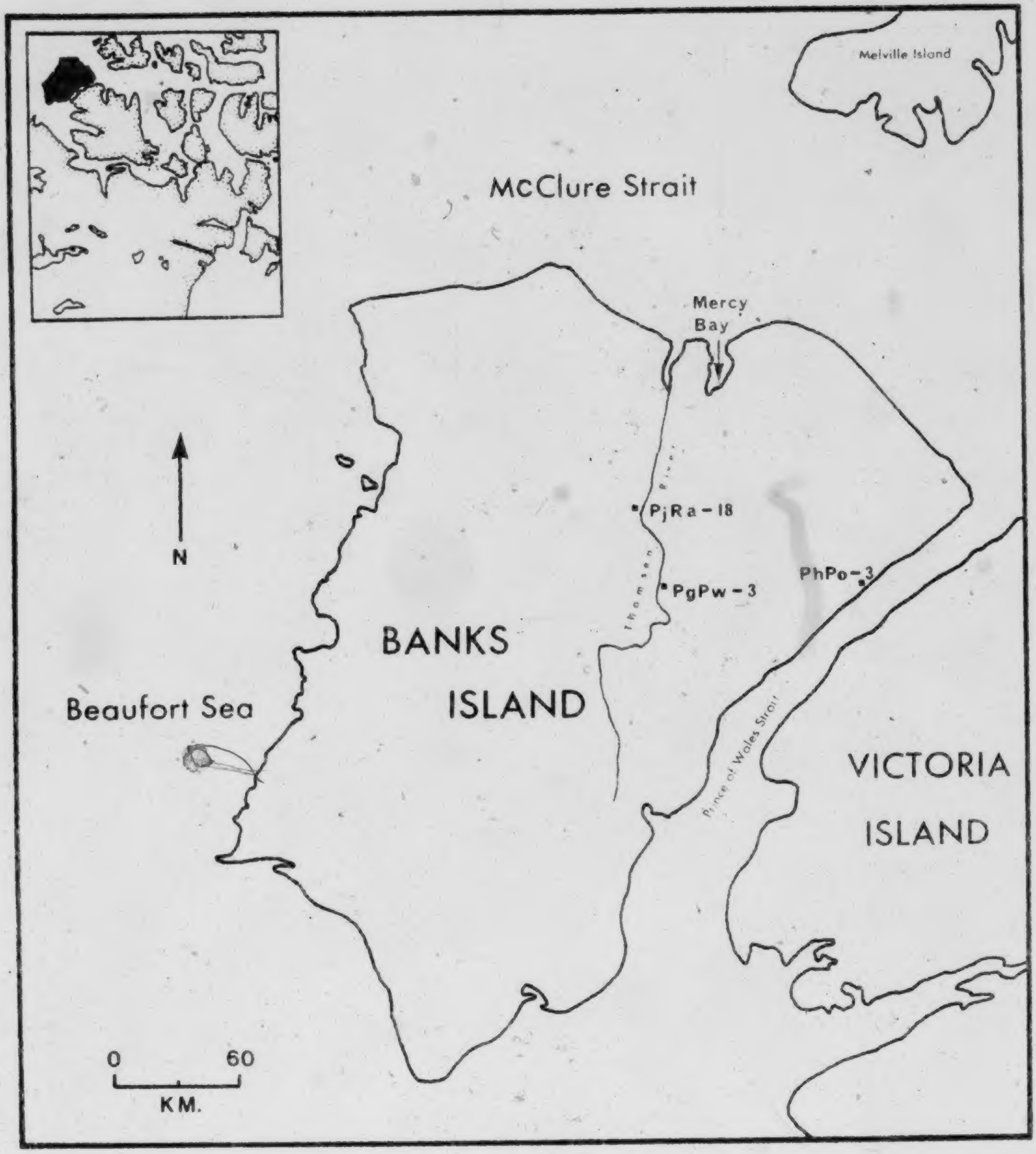

Melville Island
McClure Strait
Mercy Bay
N
Thomsen River
PjRa-18
PgPw-3
PhPo-3
BANKS ISLAND
Beaufort Sea
Prince of Wales Strait
VICTORIA ISLAND
0
60
KM.

Figure 5.1 Location of Haogak (PhPo-3), Nasogaluak (PgPw-3) and Kuptana (PjRa-18 Copper Inuit archaeological sites.

Each of these criterion is discussed below.

First, sites belonging to the appropriate cultural and chronological period required identification. The prehistory of Banks Island is relatively unknown, although limited archaeological evidence demonstrates at least intermittant occupation over the last 3400 years. The earliest dated location is the Umingmak Site (PjRa-2), located about 20 km SW of the Kuptana Site (PjRa-18). Three C-14 dates provided an average age slightly in excess of 3400 years B.P. (Muller-Beck et al. 1977:5). Umingmak was first visited in 1965 and reported as a Pre-Dorset campsite (Taylor 1967). Subsequent field investigations by Muller-Beck in 1970 and 1973 yielded a large number of Pre-Dorset lithic, antler and bone artifacts, as well as a large quantity of butchered muskox bones (Muller-Beck et al. 1977). Muskox osteological remains predominated in the faunal sample.

Paleoeskimo occupations are not confined to the northeastern portion of Banks Island, since evidence for them is also found near the Masik River along the southern coast (Arnold 1981). The Lagoon Site (OjRl-3) is dated approximately 1000 years more recent than Umingmak, but contains diagnostic Pre-Dorset artifacts. Marine and terrestrial mammals, as well as an abundant avian fauna are listed in the site zooarchaeological inventory.

No archaeological remains have been discovered to bridge the gap between Pre-Dorset and Thule occupations, although remains of the latter are reported from southern

Banks Island. Thule house structures are located in the southwest corner at Cape Kellett and near Sachs Harbor. Dendrochronological samples obtained from wood associated with the Cape Kellett houses yielded dates of A.D. 1466 and 1468 (Manning 1956:24). Archaeological materials diagnostic of Thule Culture were also found on the southeast coast at Cape Cardwell and south of Nelson River. Houses at Nelson River were constructed of whale bone, and wood and caribou antler artifacts were abundant (Manning 1956:26).

The north-central part of the island has been most intensively surveyed for archaeological sites. Several archaeological surveys were conducted there in the mid 1970's, but were never published. Since the inception of the Copper Inuit Research Project in 1978 under the direction of Dr. Clifford Hickey (pers. com. 1984), 192 sites have been located on this portion of the island. The majority of the sites can definitely be associated with Copper Inuit culture.

Although the entire island has not been systematically surveyed for archaeological remains, Copper Inuit sites appear to be confined to an area extending from De Salis Bay north along the east coast to a spot just north of the Haogak Site (PhPo-3), and encompassing a large portion of north-central Banks Island. (Hickey 1982). The sites chosen for investigation are located in the northern part, and all contain evidence pointing to an occupation post-dating the abandonment of the H.M.S. Investigator. Materials (e.g.

metal, wood, or glass) either collected from the ship or its cache were found in all three sites. In addition, antler, and perhaps wood, were processed on the sites with metal saws (Cole-Will 1984). Artifact forms are also consistent with a 19th Century Copper Inuit affiliation (see McGhee 1972 and Jenness 1946).

Cultural materials which do not necessarily post date the Investigator incident were found in two of the study sites. Their presence is ambiguous, and they do not invalidate the inclusion of the sites into the study sample. A single, non-diagnostic quartzite flake and core were located in a tent-ring at PjRa-18, and an isolated quartzite cobble with flake debitage was discovered on the periphery of the Nasogaluak Site (PgPw-3). It is not known whether 19th century Copper Inuit practiced stone flaking, since no mention of it is made in the historic and ethnographic literature.

Second, well preserved cultural and osteological materials were required for analysis. Low temperature and aridity were probably responsible for the excellent preservation of bones observed in most sites visited on northern Banks Island, including older occupations such as Umingmak. Meteorological readings taken in Sachs Harbour at the southwest corner of the island document that the annual average number of frost-free days for the period 1941-1970 is 15, and that the mean monthly temperature did not exceed 8° C between 1955 and 1970 (Maxwell 1980:175,276). Similar or colder weather conditions are postulated for northern Banks Island.

Morphological characteristics attributable to bone weathering agents (Tappen 1969; Behrensmeyer 1978; Bonnichsen and Will 1980) were uncommon on zooarchaeological specimens recorded at any of the three sites. In fact, preservation was so remarkably good that even dried periosteum was often still attached to the surfaces of bones such as scapulae and humerii. Articulated muskox tarsals were discovered under a flagstone at the Kuptana site with dessicated muscle tissue still clinging to them.

Aside from weathering agents, carnivore feeding habits also leave distinctive morphological alterations on bone surfaces (Bonnichsen 1973; Binford 1981; Haynes 1982). The extent of bone destruction due to carnivores partially depends upon the type of food available and its abundance. Bone cylinders, produced when canids chew off long bone ends are diagnostic of extensive bone destruction (Haynes 1980; Binford 1981). Carnivores also transport bones away from areas where they were initially obtained (McKinney 1974; Brain 1981).

Jenness (1922) observed that the Copper Inuit relied on dogs for hunting, and for transporting food and equipment. As reported in Chapter Three, dogs aided hunters by reducing muskox flight distance and causing animals to form characteristic defensive circles. It is also interesting to note that when Copper Inuit families were first contacted by

Europeans they rarely owned more than two animals (Jenness 1922:82). The number of dogs owned by families increased when the people began to accumulate more material items through trade with Whites.

The Haogak site produced the only direct physical evidence for the presence of dogs. The evidence consisted of a left dentary which possessed various osteological features characteristic of domesticated canids. However, implements used to harness animals were discovered at all three sites. Dogs or other canids apparently did have access to the muskox bones, since characteristic gnaw marks were noted on some long bone articular ends. However, gnawing was not intensive; bone cylinders were not discovered at any of the sites.

Jenness (1922) noted in 1915 that the Copper Inuit he summered with on Victoria Island primarily fed their dogs discarded fish remains and broth, and that animals were often tied to boulders near their owner's tents. Nineteenth century Banks Islanders may have fed their dogs similarly. Fish bones were discovered in all of the archaeological sites, demonstrating fish availability and use by the inhabitants. In addition, animals would not have been capable of removing discarded bones from camp if they were tethered. Consequently, dog feeding habits do not appear to have been a major source of modification to muskox osteological assemblages at the Haogak, Nasogaluak and Kuptana sites.

Camps may have been occasionally scavenged by wolves and foxes, but only after site abandonment, and therefore, probably after the majority of usable food had been consumed or securely stored in caches. Scavenger impact to the archaeological assemblages of muskox bones was probably minimal. However, no direct evidence to test this assertion is available from any of the sites.

Third, sites containing materials exposed at the surface were selected for study in order to retrieve a large amount of information without the need for time consuming excavation. This was because the field season on Banks Island is brief, generally consisting of 6 or 7 weeks between late June and mid-August. Sites may be obscured by snow cover before this period, and the weather is too disagreeable for outdoor work after mid-August. The contents of all three sites were visible on the surface except in some tent-rings, where materials were often located under flagstones, and because vegetation frequently filled the stone circles.

Plant density and distribution over the sites were quite variable. The Kuptana site possessed the most continuous vegetative cover, whereas plant distributions were more patchy on the other two sites. Surface ~~and~~ sub-vegetation faunal samples were collected from each site for the purpose of specifying which bone elements and size groups were being under-represented. Not surprisingly, those bones which tended to be obscured by vegetation were small ones, including carpals, tarsals, phalanges, and bone fragments. Such items are probably greatly under-represented in the MNI counts.

Fourth, since one aspect of the project involved examining how resources were procured and utilized by the Copper Inuit in different situations, sites were chosen which were located in differing environments. In addition, initial examination of the sites by Hickey suggested functional and seasonal differences to him as indicated by variation in structural types. For example, one site (Nasogaluak) possessed numerous stone caches and few tent-rings, while another (Haogak) exhibited the reverse situation. This led Hickey to hypothesize that these sites represented essentially complementary units of the seasonal subsistence system operating during the 19th century on the island.

Fifth, and finally, were logistical considerations relating to site accessibility and camping suitability. Crew and gear were flown to Banks Island via Resolute Bay (Little Cornwallis Island, N.W.T.) in a Twin Otter aircraft. Reasonably flat and stable landing surfaces had to be located near all sites for which aircraft was essential in transporting research crews (as opposed to walking surveys). This logistical contraint was an important factor in site selection. Even so, a 25 minute walk from the base-camp was required to reach site PjRa-18. In addition, the local availability of potable water was an essential consideration in choosing base-camp locales. As a result, many promising sites could not be examined in the intensive manner described below. Nevertheless, those selected on the above criteria by Hickey satisfied the basic needs to resolve the research design.

Site descriptions

Descriptions of the Haogak, Nasogaluak, and Kuptana archaeological sites are not intended to be comprehensive. Instead, emphasis is placed on documenting variation among the three occupations with respect to local geography, faunal remains, stone features, and types of archaeological sites found in the surrounding regions. Additionally, comments about wildlife observed in the vicinity of the sites during the field season(s) are provided, and the work completed on the sites is noted. This information will be referred to in Chapter Six.

Haogak site (PhPo-3)

The first site to be described, Hoagak (PhPo-3) was discovered during helicopter survey in 1981 (Hickey 1981), and it is situated about 3 km from the northeast coast (Figure 5.1). It is 150 m above sea level (a.s.l.) on the uppermost terrace of a small river valley (Plate 5.1). A frost-cracked plain composed of fine sediments, gravel, cobbles and an occasional boulder characterizes the well drained site area. It is very flat, and the sediments are compact providing the only local, suitable land spot for the

Plate 5.1 The Haogak Site (PhPo-3) facing Prince of Wales Strait (northeast).

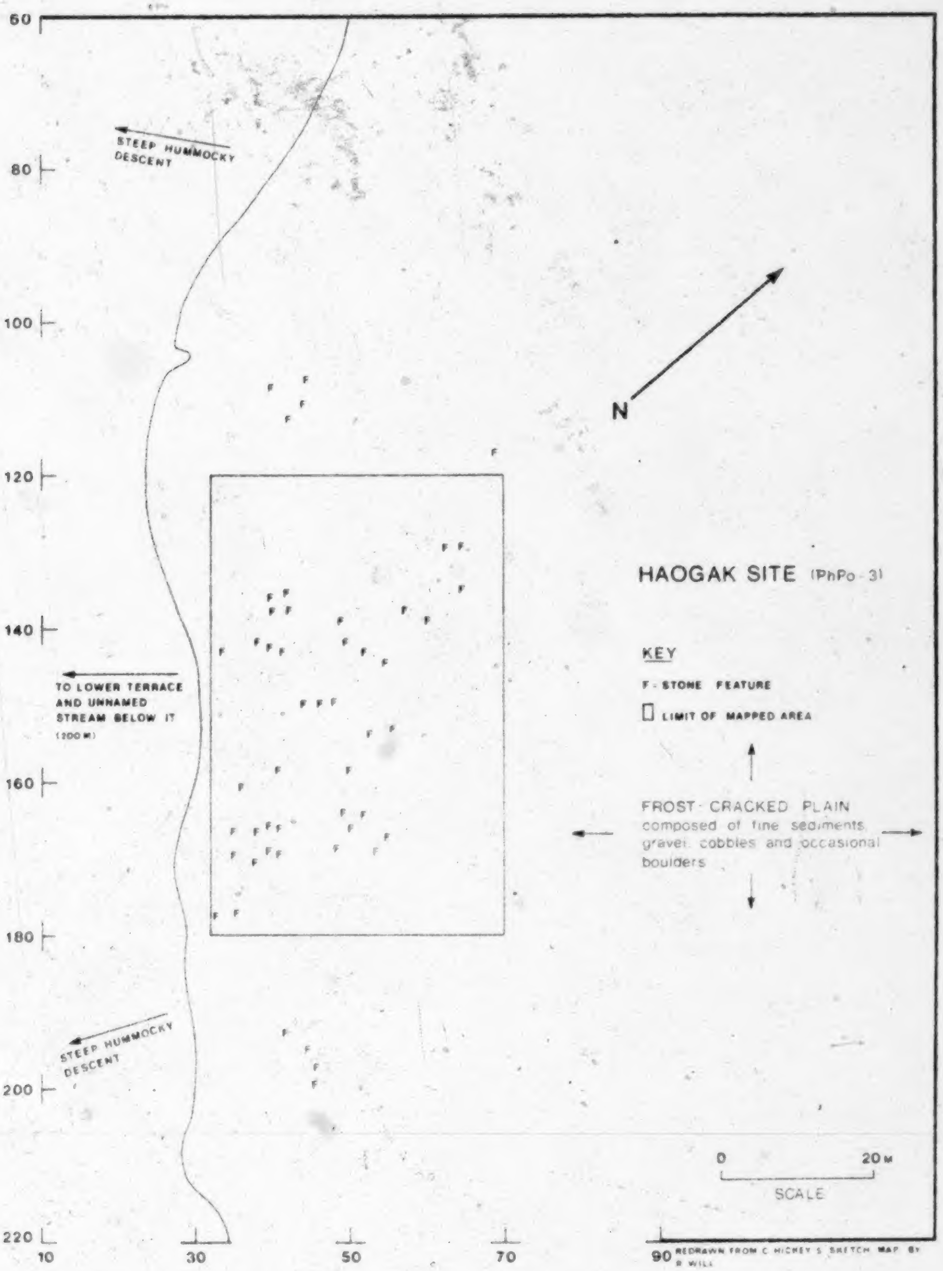
Twin Otter aircraft.

A relatively broad but discontinuous terrace of wet sedge (Carex stans) meadows occurs 10-15 m in hummocky descent below the site. An unnamed river is about 50 m below it. The river flows through a narrow valley which abruptly opens onto the coastal plain. It eventually empties into Prince of Wales Strait.

Vegetation on and around the site consisted mainly of willow (Salix pseudopolaris) and dryas (Dryas integrifolia). In general, plant cover was sparse, and similar to that of the barren uplands around the northern Thomsen River drainage (Wilkinson and Shank 1974:68). However, the site was more densely vegetated than the surrounding area.

Wildlife was not particularly abundant in the region with only a few animals being sighted during fieldwork. A total of eight muskoxen were observed within a 3 km radius of the site in 1981. A single arctic fox made regular camp visits. Four muskoxen were observed feeding directly below the site in the wet sedge meadow in 1982. Also, while on foot survey in 1982, three polar bears (*Thalarctos maritimus*) were seen off the coast directly northeast of the site.

The majority of the Haogak Site is concentrated in an area of approximately 2600 m² near the terrace edge (Figure 5.2). It was intensively investigated by a 6 member crew over a 9 day period (July 28 - August 6) in 1981. A area of 2264 m², or 87% of the site surface was mapped.


HAOGAK SITE (PhPo-3)
KEY
F - STONE FEATURE
LIMIT OF MAPPED AREA
FROST-CRACKED PLAIN composed of fine sediments, gravel, cobbles and occasional boulders
STEEP HUMMOCKY DESCENT
TO LOWER TERRACE AND UNNAMED STREAM BELOW IT (200 M)
STEEP HUMMOCKY DESCENT
N
0
20 M
SCALE
60
80
100
120
140
160
180
200
220
10
30
50
70
90

REDRAWN FROM C HICKEY'S SKETCH MAP BY R WILL

Figure 5.2 Location of features and mapped area on the Haogak Site (PhPo-3).

A total of 14,013 items (including artifacts, structural stones and bones) were located and identified. Sixty-one percent, or 8517 specimens, were muskox osteological remains, but they constituted 85.3% of the faunal inventory. Muskox skulls and vertebral columns were abundant (see Plate 5.2). Bones or bone fragments identified as caribou, Arctic hare (*Lepus arcticus*), snow goose (*Chen caerulescens hyperborea*), loon (*Gavia sp.*), and unidentified birds and fish constituted the remainder of the faunal collection. In addition, a single left dentary of a domestic dog was also discovered on this site.

Stone features included tent rings (some with excavated floors), caches and stone rows (function unknown). Their distribution in relation to the mapped area is shown in Figure 5.2. Tent rings were the most common feature, and some of them also occurred off the sampled area, but with little or no associated bone.

A survey of the region around Haogak was conducted, but few archaeological sites were located. Opened, vault caches situated in a row on top of a gravel ridge about 2 km northeast of the site were discovered during a hike to the coast. No faunal remains were noted near any of the stone features. Another site (PhPo-6), located even closer to the coast was situated on a prominent gravel feature. Although this small site was only briefly visited, it was determined that muskox bones were the most abundant faunal remains, and that seal and bird osteological materials were present. In

Plate 5.2 Muskox skeletal parts on the Haogak Site (PhPo-3).

addition, an almost complete harpoon used for breathing-hole sealing was found at this site.

A single kill-site containing one incomplete muskox skeleton was also located en route to the coast.

Nasogaluak site (PgPw-3)

The Nasogaluak Site (PgPw-3) is positioned along the Thomsen River approximately 70 km upriver (south) of Kuptana, and 90 km west of the Haogak Site (see Figure 5.1). Its elevation is 95 m a.s.l. The river is about 25 m below the site, and the moderately steep descent to it is hummocky. Most of the site sits on a prominent bluff commanding an excellent view up and down the Thomsen River valley (Plate 5.3). The valley is broad with little topographic variation in this area, and the river meanders across a wide and often sandy flood plain.

Wildlife, both avian and mammalian, was plentiful in the site region. Muskoxen were seen individually, in small groups, and in one instance, in a herd of 19 animals. On two occasions, they were observed less than .25 km from the site. Several caribou were also seen. A family of foxes denning near Nasogaluak made frequent visits to the camp and site.

The contents of Nasogaluak are discontinuously spread over a large area measuring about 20,000 m^2. There are two concentrations of materials; one is along the bluff edge paralleling the river, and the other, which contains only stone features, is located a few hundred meters to the east

Plate 5.3 The Nasogaluak Site (PgPw-3) facing south.

of the first.

The Nasogaluak site was initially located during survey in 1978 (Hickey 1978:13); however, intensive investigation was not undertaken until a two week period (July 12-27) in 1981. A total of 1880 m² were mapped in two descrete areas along the bluff edge where faunal remains were found (refer to Figure 5.3). It represented about 65% of the total area in that site portion. The terrain along the bluff edge is flat and for the most part, well drained. However, a low lying area, densely vegetated and poorly drained, does bisect it. Vegetation is sparse in the well drained spots and consists mostly of willow (S. pseudopolaris). The wetter areas are dominated by dryas (D. integrifolia).

Muskox osteological remains totaled 6,526 specimens, or 58% of the site sample (11,200 items) and 90.6% of the faunal inventory. Axial parts were notably absent from Nasogaluak, but large concentrations of smashed muskox bone occurred at several locations. Other bones and bone fragments which were identified as: caribou, polar bear, ringed seal (Phoca hispida), arctic hare, snow goose, ptarmigan (Lagopus sp.), loon, Snowy owl (Nyctea scandiaca), and unidentified birds and fish made up the remaining 9.4% of the zooarchaeological sample.

Stone features were abundant on this site in contrast to Haogak. About 100 stone structures were located, and included tent-rings (complete and partially dismantled), vault caches, dismantled caches, qarmat-like structures,

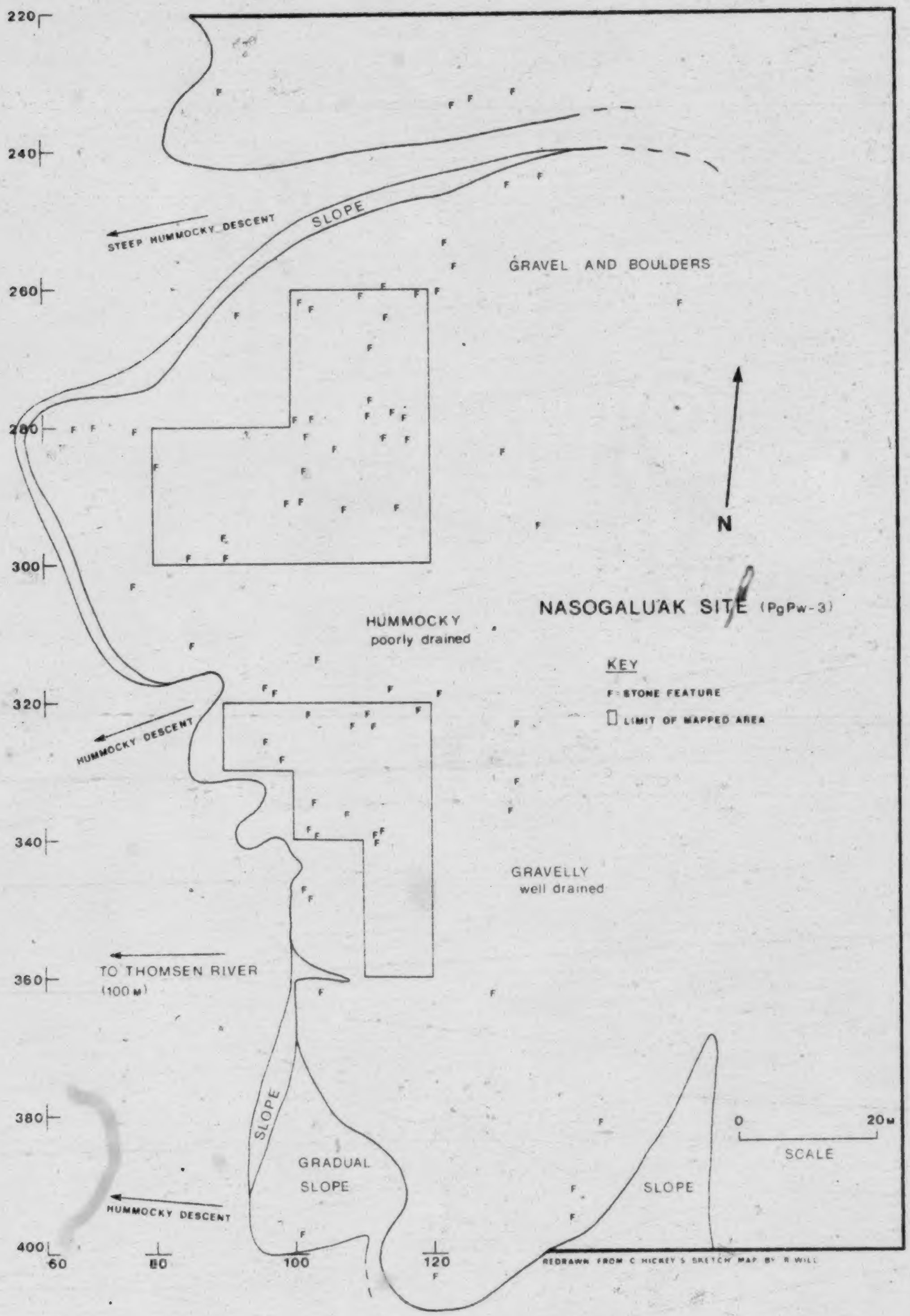

NASOGALUAK SITE (PgPw-3)
KEY
F: STONE FEATURE
LIMIT OF MAPPED AREA
N
GRAVEL AND BOULDERS
SLOPE
STEEP HUMMOCKY DESCENT
HUMMOCKY
poorly drained
HUMMOCKY DESCENT
GRAVELLY
well drained
TO THOMSEN RIVER
(100 M)
SLOPE
GRADUAL
SLOPE
HUMMOCKY DESCENT
SLOPE
0
20M
SCALE
220
240
260
280
300
320
340
360
380
400
60
80
100
120
REDRAWN FROM C HICKEY'S SKETCH MAP BY R WILL

Figure 5.3 Location of features and mapped area on the Nasogaluak Site (PgPw-3).

flagstone paved areas, and wind breaks (Hickey 1981). Vault caches, many constructed with stones weighing over 50 kg, predominated in both portions of the site. In fact, they were the only archaeological feature east of the intensively mapped part of the site.

Survey of the surrounding area revealed several muskox kill-sites. Without exception, they were characterized by a lack of appendicular skeletal parts. Individual, as well as multiple kills were found. One site (PgPw-2) about .5 km northeast of the bluff contained the remains of two bulls (Figure 5.4). A ringed seal tibia and femur were found lying at the sagittal end of an articulated, vertebral column belonging to one of the bulls.

Two additional sites were located in the vicinity of Nasogaluak, but on the opposite side of the river. One (PhPw-11) contained stone caches and an abundance of bird bones. It is about 3 km downriver from PgPw-3 on the west bank. The other site (PgPw-6), is situated almost directly across the Thomsen River from Nasogaluak. It possessed no structural features, but did contain various artifacts (snow knife, bone pin, metal cooking pot, etc.) scattered over a sandy area along the river edge.

Kuptana site (PjRa-18)

The Kuptana site was discovered undisturbed in 1978 (Hickey 1978). It is located in the northern Thomsen River drainage at an elevation of 120 m a.s.l. (see Figure 5.1). Mercy Bay is approximately 60 km due north of the site.

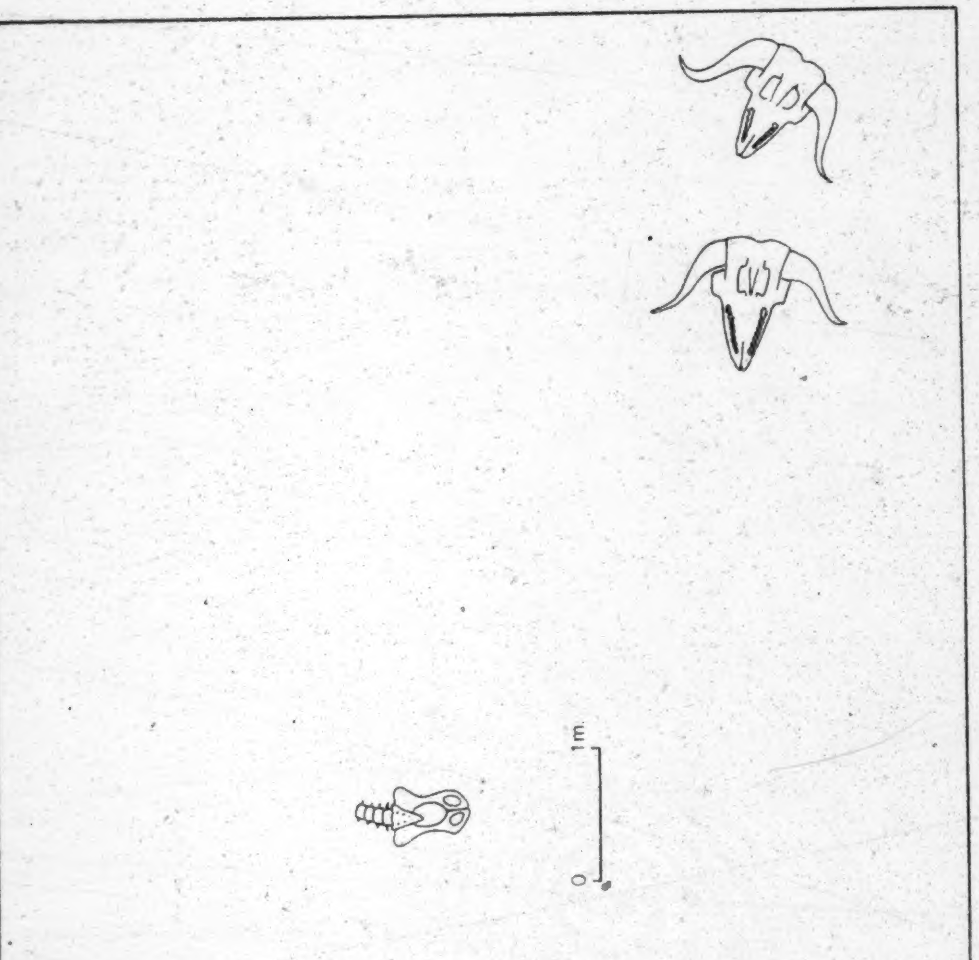


Figure 5.4 Kill-site of two bull muskoxen located about .5 km northeast of the Nasogaluak Site (PgPw-3).

The site is situated on the barren uplands characteristic of this part of the island (Wilkinson and Shank 1974:68) about 1.5 km west of the Thomsen River. An impressive view of the surrounding region is available from it (Plate 5.4). The river loops across a wide flood plain below the site; dune topography and sparse vegetation characterize areas immediately adjacent to the Thomsen. The low lying area between Kuptana and the river is punctuated by numerous, small ponds - many separated by raised levees. Sedge (*C. stans*) predominates in these meadows.

Birds and mammals were abundant in the site region. Kuptana is located within Banks Island Bird Santuary No. 2, and ducks, geese, sandhill cranes, snowy owls, jaegers and a variety of songbirds were commonly seen. Muskoxen were sighted almost daily in the meadows below the site, and they occasionally wandered close to camp. Table 3.3 presents data collected on animals seen in the area in 1982. Caribou were infrequently observed; only 5 individuals were spotted in 1982. Other mammals recorded in the vicinity of PjRa-18 include: arctic foxes, arctic hares and lemmings.

Kuptana is an extensive site covering an estimated 20,000 m^2. Sandstone rock outcrops are present at the north and south site ends, and a total of 120 open, vault caches occur on them. Archaeological materials are scattered more or less continuously, except in areas adjacent to the cache concentrations. Vegetation is widely distributed over the site; however, faunal material is readily visible in the

Plate 5.4 The Kuptana Site (PjRa-18) looking upriver (south).

plant cover dominated by willow (S. psuedopolaris) and dryas (D. integrifolia).

Intensive fieldwork was carried out at this site over a three year period beginning in 1980 (Hickey 1981). A total of 9600 m² were mapped, covering about 50% of the site area (Figure 5.5). Artifacts, faunal material and stones comprise the inventory of 36,507 catalogued and mapped specimens which do not include specimens recorded by excavation in the north and south habitation areas.

The most impressive characteristic of this site aside from its large size is the quantity of muskox bones spread over it. Seventy percent of the items identified in the site inventory are muskox osteological remains (25,554), and they compose 83.4% of the faunal sample. A minimum of 375 skulls were observed in 1978, and over 100 of them were concentrated in one single area less than 50 m in diameter (Hickey 1978:39).

Snow goose bones were the second most abundant faunal remain. They totaled at least 1752 specimens, and represented 5.7% of the faunal inventory. Other species which were identified in the zooarchaeological sample included all of the species mentioned for the other sites, as well as Arctic wolf (*Canis lupus spp.*)

At least 35 large and small stone tent-rings are present on Kuptana. They are not evenly distributed over the site, but occur in clusters at the north and south ends. Other features, in addition to the vault caches already

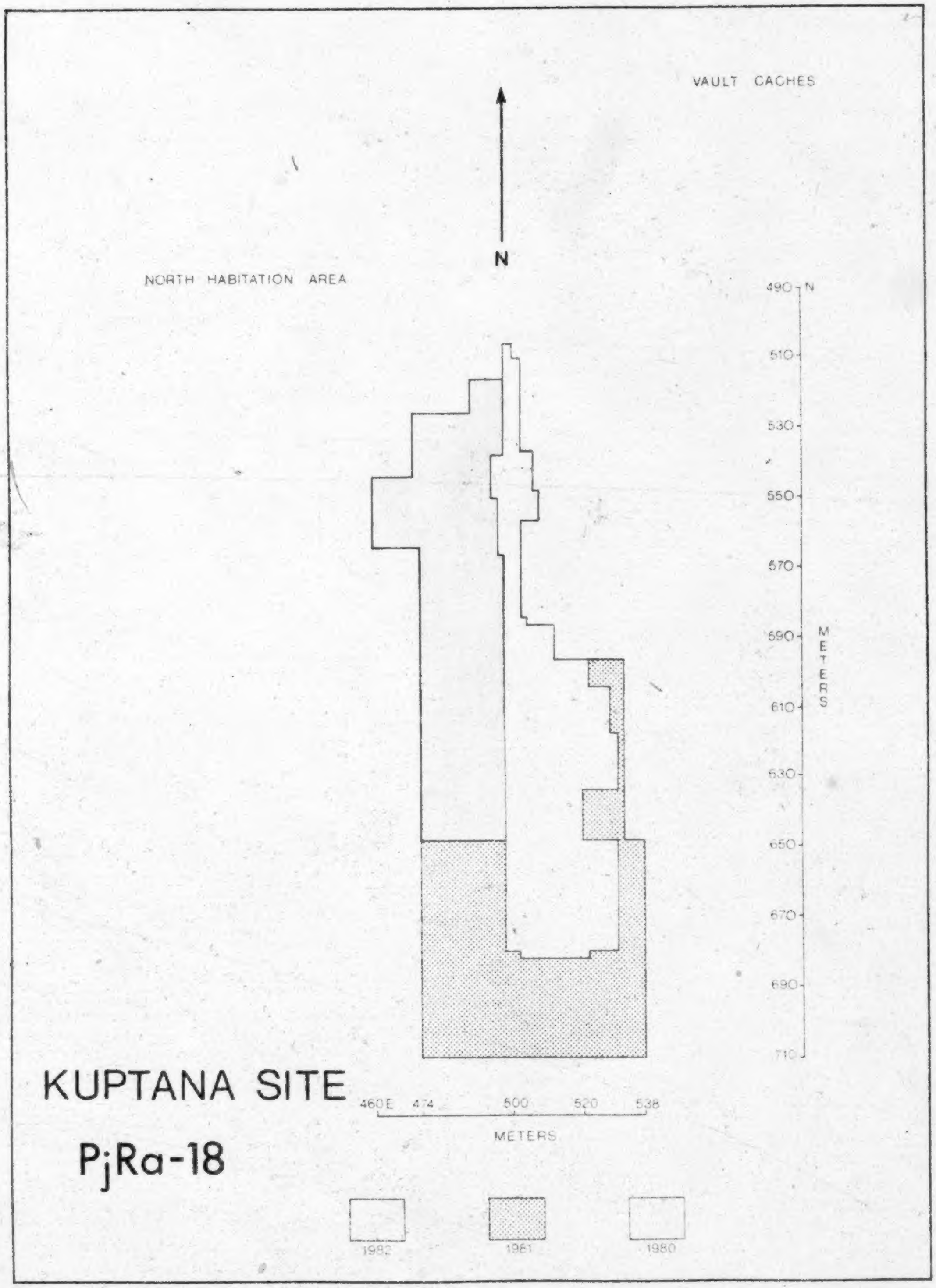

VAULT CACHES
N
NORTH HABITATION AREA
490 N
510
530
550
570
590
610
630
650
670
690
710
METERS
KUPTANA SITE
PjRa-18
460 E
474
500
520
538
METERS
1982
1981
1980

Figure 5.5 Location of mapped areas on the Kuptana Site (PjRa-18).

mentioned, are muskox ribs stuck upright into the ground, and arranged into circular patterns. The rib rings measured about 2m in diameter, and were probably used for stretching and drying skins.

Other Copper Inuit sites have been located on foot survey in the area around PjRa-18. They include: single and multiple muskox kill-sites, isolated tent-rings, hunting blinds, and smaller campsites. Of particular interest is another large, residential site located approximately 15 km north of PjRa-18 and referred to as Head Hill West (PlPx-1). At least 17 structures are present, and 543 muskox skulls were counted on the surface (Wilkinson and Shank 1975:104). Across the Muskox River and almost opposite Head Hill West is another substantial encampment (PkPx-2) in which 25 structures divided into two clusters are visible. Wilkinson and Shank (1975) counted 134 muskox skulls at this locality. Faunal remains of species other than muskoxen were present but in much fewer numbers, at both sites.

In summary, the three archaeological Copper Inuit sites, Kuptana, Nasogaluak and Haogak possess several important characteristics which make them ideal for zooarchaeological analysis. All contain well preserved osteological material in a well defined temporal context. In addition, the majority of archaeological remains are exposed facilitating rapid data recovery. Finally, one mammalian species, muskox, is the principal component of all faunal assemblages even though site topographic situation and internal organization are variable.

The methods employed to collect faunal data are described next. They were designed to obtain large amounts of zooarchaeological information rapidly with minimal disturbance to the sites.

Methods

Introduction

Kuptana (PjRa-18) was the first Copper Inuit site intensively studied (Hickey 1981). Fieldwork was initiated there by Hickey and a crew of 5 in 1980. Standardized data recording procedures were implemented that season, and they were adopted with some modifications for subsequent fieldwork in 1981 and 1982. A 2 m grid system was laid over the site once its perimeter had been visually determined. The baseline was oriented so as to bisect the site east to west. All archaeological materials occurring in a grid square were located with reference to the NW corner. Squares were designated with a pair of 3 digit coordinates.

The locations of artifacts, bones and structurally related stones were marked on sheets graduated in 10 cm^2 units. A keyed identification list of all materials was provided on an accompanying sheet. Consequently, very few osteological specimens were removed from the site. An exception to this practice was collection of muskox teeth for dental annuli analysis.

Photo-mapping methods

Surface exposure of archaeological materials made feasible a photo-mapping data collection strategy. Hickey photomapped portions of PjRa-18 in 1980 using a quadrupod (plastic pipe construction) attached to a 2 x 2 m frame. A 35 mm single reflex camera fitted with a 28 mm wide angle lens was mounted 3 m over the frame center. The shutter release mechanism was tripped with an air bulb. Unfortunately, technological complications beyond the investigator's control resulted in failure of the shutter to function properly mid-way through the field season. No data loss occurred, however, since written field records were also kept.

Large portions of the Nasogaluak and Haogak sites were photo-mapped in 1981, but with several innovations to the system previously used by Hickey. First, a free-standing tripod was substituted for the fixed-leg quadrupod (Plate 5.5). Light-weight aluminum was used to construct the tripod and a 2 x 2 m frame. It possessed an advantage over plastic in that it did not crack in cold weather, or warp through constant use. The free-standing tripod was easier to level over grid squares with uneven surfaces or over features, such as large stone caches.

Another difference was that all films were developed in the field so that proper negative exposure and alignment over grid squares could be checked. The black and white films (Panatomic - X) were developed within a day or two of

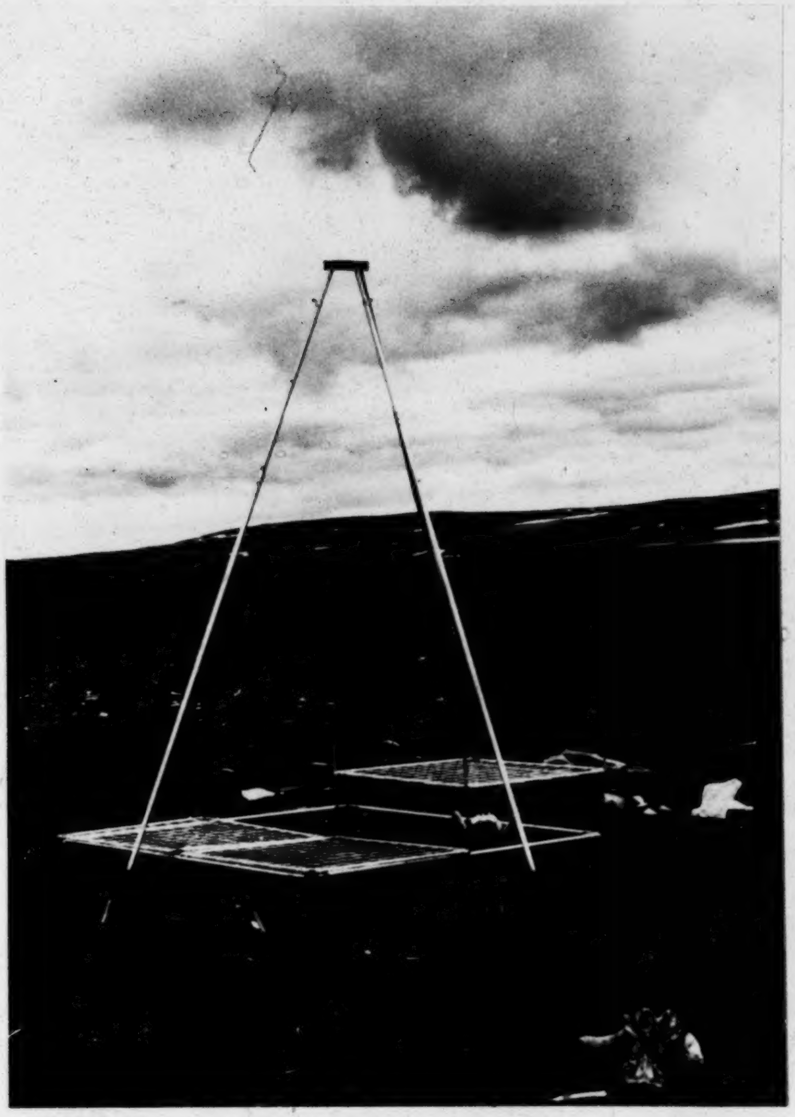


Plate 5.5 The tripod system used for photo-mapping the sites.

exposure using standard techniques.

Written record sheets were still maintained; however, time spent preparing them was substantially reduced. Since resolution was excellent (see Figure 5.6), much information could be coded directly from the 20 x 20 cm photographs using a microcomputer cataloging system developed by Terrance Gibson (Department of Anthropology, University of Alberta; see Gibson et al. 1981). For example, long bone fragments and stones were digitized directly from photographs so that only general feature locations rather than precise coordinates of individual bones or stones were noted on grid sheets.

Microcomputer methods

There are a variety of ways in which zooarchaeological data can be organized and coded for computer storage and manipulation (for example, see McArdle 1976, Bonnichsen and Sanger 1977, and Gifford and Crader 1977). Generally, all data are translated into a numeric string code which includes provenience and identification information for a single osteological specimen. A unique numeric code is given to each skeletal element. Additional numeric assignments are made for bone portion, anatomical side, age and sex. For purposes of analysis, categories of coded information are located in prearranged slots of fixed width within the numeric string. The coded data are then entered into a mainframe computer via punched cards or visual display terminal.

Plate 5.6 Photograph of Haogak grid square (162/044).

An Apple II+ 48K microcomputer with peripherals was initially used to catalog and store Banks Island data. Its use in conjunction with the software developed by Terrance Gibson provided several advantages over other systems. First, osteological data were translated into string code by machine rather than operator. A BASIC language program used in conjunction with a visual monitor prompted the individual entering information with a series of questions (and possible responses). The questions concerned categories of osteological information considered necessary for analysis. After all questions had been answered, the program generated an alphabetic string code - one line of characters for each specimen described. Alphabetic codes were easier to translate and check for errors than numeric ones, because of their mnemonic association with English terms (eg. "axial" was entered as "AX").

Second, precise coordinates locating each specimen within a 2 m grid square were automatically determined by the program, and included within the string of coded identification information. This was accomplished with the use of a 1000 cm² digitizer. Square photographs or field grid sheets were oriented on the tablet. The program asked the recorder for square coordinates (NW corner) and scaling information. When prompted, the recorder touched the electronic pen to the bone or artifact image and its exact location within the square was computed.

Third, the system was time efficient, and could be operated by inexperienced individuals with a minimal amount of training and supervision. Data were entered into the computer system directly from field records. A practiced recorder could catalog as many as 100 specimens per hour.

Fourth, the Apple and its associated components were compact and light-weight. Everything fitted into a plywood carrying case measuring 82 x 61 x 41 cm, and weighing 41 kg. They were taken into the field in 1981 and powered with a wind generator. Consequently, archaeological information collected daily was computerized immediately.

Some issues regarding bone identification procedures in the field require mentioning since they determined how data were coded with the microcomputer, and ultimately how MNI estimates were calculated. Bone elements or element portions were identified as left, right or indeterminate. Unfortunately, not all bones were sided in the field. Diagnostic morphological criteria were occasionally obliterated from specimens making side recognition impossible. Also, field recording of the appropriate information was sometimes overlooked.

Only whole animal MNI counts were affected by the absence of side information for all specimens. The problem was dealt with in the following manner. A preliminary MNI was derived from the left or right side - whichever yielded the largest count. A conservative approach was taken for calculating MNI estimates with indeterminate specimens.

Following Binford's (1978:70) reasoning, left and right anatomical portions probably had an equal opportunity for inclusion into the archaeological record. However, differences between side counts do exist, and can be attributed to several sources of bias, including sampling error, meat distribution and/or consumption at more than one location, and random side destruction resulting from activities such as grease production and carnivore feeding. Therefore, the indeterminates were treated as a dependent rather than independent population. Lefts and rights were equalized by subtracting the necessary number from the indeterminate category. If any indeterminates remained after this operation, their total was divided by 2 and rounded up to the nearest whole animal. An actual example of this procedure is illustrated with muskox bones from the Haogak site. Thirty-one proximal, fused tibia were identified (see Table 6.2) and mapped. Fifteen of them were left, 12 were right, and side determination was not made on 4 of them. The lefts and rights were equalized by subtracting 3 from the indeterminate group leaving a total of 1. The whole animal MNI for this remaining specimen is 1, and when added to the side MNI of 15, the whole animal estimate for proximal, fused tibiae is 16. Obviously, there is no justification for assuming that any of the indeterminate specimens were actually from the right side. However, by using this method, no fewer than 16 muskoxen could possibly have been dispatched.

Similar procedures were used on bones whose epiphyses were unfused. Occasionally, epiphyses and diaphyses were found in isolation. Those associated together or in immediate proximity to one another were given a single computer entry. The MNI calculation for unfused long bone portions was based on a count of specimens with both epiphyses and diaphyses plus the isolated diaphyses or epiphyses (whichever yielded the largest number).

The long bones of very young muskox calves were never broken to extract marrow. Diaphyses were much more frequent than epiphyses, and the former were always used to calculate the MNI for individuals less than 6 months old. With only a few exceptions among the thousands of examples in the three sites considered here, all long bones of older animals were broken.

Vertebral MNI counts were tabulated in a manner similar to long bones. The total number of specimens in each vertebral group (cervical, thoracic and lumbar) were divided by the number of individual elements per group (seven cervical, 13 thoracic and five lumbar). Another example taken from the Haogak Site osteological sample (Table 6.2) will illustrate this point. Muskox cervical, thoracic and lumbar vertebrae totaled 342, 559 and 252, respectively. When the group totals were divided by the number of individual elements per group and rounded up to the nearest whole animal, the vertebral MNI counts were 49, 43 and 51, respectively.

A category of indeterminate vertebrae is also present in each site sample. Included within it are specimens with all diagnostic morphological criteria obscured. These specimens were treated in the same fashion as long bone portions whose sides could not be identified. First, sufficient vertebrae were subtracted from the indeterminate group to equalize vertebral MNI. For example, when sufficient indeterminate vertebrae from the Haogak Site assemblage were added to the cervical, thoracic and lumbar totals to yield 51 whole animals (MNI of lumbar vertebrae), a deficit remained in the indeterminate category. Therefore, the MNI for the indeterminate vertebrae was 0. The same was characteristic of indeterminate vertebrae MNI at the other sites.

A few exceptions, noted earlier, remain to be discussed. Rarely were side determinations made on carpals and tarsals. Neither phalanges nor metapodials were sided or identified as belonging to either the front or rear legs. Consequently, whole animal MNI counts for these elements were calculated in a manner similar to Binford's (1978:70). The element total was divided by the number present in one animal. However, all MNI counts were rounded up to the nearest whole animal rather than leaving a fraction.

Unfortunately, anterior and posterior mandibular fragments could not be used to estimate MNI, because diagnostic features to associate one or more fragments with a single mandible were not systematicaly recorded. The same problem also occurred among indeterminate mandibular fragments, indeterminate pelvic fragments and scapulae blade fragments. Only totals for these categories are listed in the MNI site tabulation tables.

In addition, rib articular facets were not distinguished from rib fragments or complete ribs. Therefore, the rib count which appears in each table cannot be used to calculate MNI. Long bone fragments are also only listed.

VI. Muskox Procurement and Use: Site Analyses

Introduction

For each of the three archaeological sites (Haogak, Nasogaluak and Kuptana), muskox bone assemblages are analyzed and compared using models generated from the food utility indices discussed in Chapter Four. Models are defined here as devices for reconstructing (and therefore, predicting) human behavior. Their formulation is guided by a particular theoretical orientation, and they are constructed with a selection of variables identified as essential for answering questions about the past. The models employed to examine Copper Inuit exploitation of muskoxen are based on a maximization approach, and the variables with which they are constructed concern the food utility (meat, marrow and grease) of carcass anatomical parts. This modeling approach was developed by Binford (1978), and it is adopted here to predict the composition of muskox faunal assemblages in the three 19th century, Copper Inuit sites on north-central Banks Island. According to Binford (1978:459):

> It is the linkage between the facts of the anatomy of animals and the realities of the execution of certain strategies that permits the modeling of faunal assemblages and hence their "identification" with certain behavioral contexts in the past. Understanding the character of the strategies and the osteological clues to their execution is crucial to the meaningful analysis of faunal remains.

The utility indices are employed to construct the food use models. Individual indices, meat, marrow, and grease, may be applied independently as models to predict the composition of muskox bone assemblages at any location where processing for one of these foodstuffs is hypothesized to have occurred. These types of models, of course, do not take into consideration other variables such as, initial transportation costs of getting food to camp, quantity of existing food resources available for consumption or abundance of food animals for procurement.

Given a maximization perspective based on food value, the %MNI of bone elements in the archaeological muskox bone assemblages are expected to show a relationship with the index values of those respective anatomical parts. For example, an assemblage of bones which was produced by processing for marrow should contain a large percentage of elements with high marrow index values (e.g. distal radius, distal tibia and distal metapodial; see Table 4.6, col. 4), and few bones with low marrow values. That is to say, if decisions regarding marrow processing were made strictly in terms of maximizing for that particular food item, a strong, positive linear relationship would be anticipated. Obviously, other considerations noted above played a role in determining what bones were made available for marrow extraction, and which ones were actually selected for processing.

When the %MNI of an element exceeds its modeled value for a particular food use, the bone portion is described as being present in percentages greater than anticipated with the model. A bone portion is said to occur in lesser quantities than expected for a specific food use when its %MNI is less than predicted with the relevant model.

The food utility indices may be variously combined to model behaviors which involve multiple decisions in the extraction of usable food resources from an animal carcass. Anatomical parts are simultaneously being selected for their meat, marrow and grease (as well as other food products, such as fat; and non-food materials, such as skins) at butchery sites. The cumulative effect is that some muskox assemblages will reflect decisions regarding the general utility of carcass anatomical parts, while others will reflect more specialized or focused utilization. Other data can then be examined to ascertain a comprehensive picture of the muskox based subsistence pattern. Binford (1978:72-75) constructs a general utility index to monitor this situation by combining all three food utility indices. Further discussion of this index, or model as it is referred to in this study, is presented later.

Obviously, several different kinds of models can be generated with the muskox food utility indices, and their appropriate selection for addressing the archaeological record is determined by hypotheses concerning Copper Inuit subsistence behavior. The models chosen for predicting muskox carcass use at the Haogak, Nasogaluak and Kuptana sites depended on an interpretation of site data presented in the preceeding chapter, reconstruction of animal procurement strategies, and additional information described below.

The use of animal resources for subsistence purposes varies along a logistical continuum (Binford 1978). Faunal assemblages may be characterized as additive or subtractive. An additive assemblage is defined here as one in which carcass portions have been introduced into an activity area for further processing and consumption. They may be as inclusive as a residential site or as specific as a special purpose location within a residential site.

Subtractive assemblages are those from which anatomical parts have been removed for processing and/or utilization elsewhere. An example of one is a kill-site. Binford (1978:460) refers to these kinds of assemblages as culled, in that only discarded anatomical parts of low utility are present.

Most site faunal assemblages will not be exclusively additive or subtractive. This is particularly true for residential sites where the overall accumulation of faunal remains has resulted from a variety of subsistence activities. Special purpose areas within larger occupation sites will almost always be additive in that carcass parts will have been imported into a specified area and then processed. Anatomical parts are not necessarily introduced into places with respect to anatomical frequencies present in whole animals, but rather in relation to the nature of the activity, eg. marrow processing or grease production. It is for this reason, among others already mentioned, that

Binford's concept of the anatomical part MNI is analytically important.

All three sites were used for residential purposes, as indicated by the presence of tent-rings, tool manufacturing debris, and discarded implements. They occur at one end of the logistical continuum (additive) in that many carcass parts may have been culled prior to introduction into these sites (unless residential locations were in immediate physical proximity to kill-sites).

The Haogak, Nasogaluak and Kuptana occupations contain only slices of Copper Inuit subsistence activities. For this reason, it is necessary to examine the opposite end of the logistical continuum to determine how muskox procurement strategies played a role in influencing the character of site faunal assemblages. Two important logistical variables which influence the composition of residential muskox bone assemblages are the transportation costs of getting food to the consumers, and the amount of food (bulk) to be transported (Binford 1978:459). Copper Inuit relied exclusivly upon dogs, sleds and human labor for transportation. Consequently, it is reasonable to expect that culling would have been most radical when transportation distance of muskox carcasses to consumers was greatest. Binford (1978:459) stated that: "the greater the bulk of material to be transported {recall that an average adult male muskox weighs 290 kg}, per unit of time, the more radical will be the culling of low utility parts along the logistical route". Therefore, it is also predicted that the degree of culling would be influenced by the number of muskoxen procured during any individual hunting episode. Because procurement strategies directly influence the composition of faunal assemblages found in any kind of habitation site, they will be considered with respect to the Haogak, Nasogaluak and Kuptana faunal analyses separately.

When animal carcasses are butchered at kill-sites, anatomical parts are selected simultaneously for meat, marrow and grease, and are imported into other locations where consumption actually takes place. The cumulative effect of procurement and processing of muskoxen for food is that some site assemblages may be composed of osteological remains that reflect the proportional value of all food products associated with each anatomical part. A model to predict what the resultant faunal assemblage would look like consists of "a weighted compound index of general utility that monitors quite closely the actual proportions of the different food components of the animal" (Binford 1978:72). The general utility model is constructed by multiplying the meat, marrow, and grease anatomical part indices by their respective weight proportions. The results are summed and then standardized on a scale of 1-100. Its construction in this study is based upon Binford's (1978) description in **Nunamiut ethnoarchaeology**, and a version of it is used here for describing the general utility of muskox anatomical parts.

Binford (1978:22) noted that the proportional weight of meat, marrow, and grease differed between sheep and caribou, and he attributed the difference to variation in body size. These data indicated to him that marrow and grease weight proportions increased at the expense of meat weight proportions with larger body size. Therefore, the food weight proportions for the largest animal studied by Binford (caribou) are used to approximate the body weight proportions of muskox meat, marrow and grease. They are 9.40, 0.48 and 0.12, respectively (Binford 1978:73).

It should be noted that these proportional differences related only to the appendicular skeleton, and not the whole skeleton. Binford inexplicably does not discuss the body weight proportions in relation to a complete carcass. The single compensation he makes is to substitute his white grease index (derived from the appendicular skeleton) for the standardized grease index. Similar procedures were followed in this study. The standardized general utility model (GUM) approximated for muskoxen is shown in Table 6.1, col. 5.

The general utility model is an unrealistic analytical tool, because hunters usually field butcher carcasses into anatomical sets composed of 2 or more anatomical parts (Binford 1978:74; see also Wheat 1972; Lyman 1979). This means that low utility parts may be introduced into other activity areas appended to parts possessing high general utility. Binford (1978:74) accomodates this problem by

Table 6.1

Construction of Approximated Muskox General Utility Models

Anatomical Part	(1) MUI × 9.40[1]	(2) MI × .48[2]	(3) GI × .12[3]	(4) Sum 1,2,3	(5) Standardized GUM	(6) MGUM Weighted	(7) MGUM Averaged
skull	230.49	.48	.12	231.09	24.57	24.57	11.23
mandible with tongue	391.51	4.43	.12	396.06	42.11	42.11	36.55
mandible no tongue	126.81	4.43	.12	131.36	13.97	13.97	24.16
atlas	174.09	.48	.12	174.69	18.57	18.57	2.47
axis	174.09	.48	.12	174.69	18.57	18.57	20.47
cervical vertebra	517.28	.48	.12	517.88	55.06	55.06	47.50
thoracic vertebra	471.97	.48	.12	472.57	50.24	50.24	66.00
lumbar vertebra	332.10	.48	.12	332.70	35.37	66.00	61.57
pelvis	764.89	4.12	.12	769.13	81.77	81.77	83.59
rib	940.00	.48	.12	940.60	100.00	100.00	55.57
sternum	835.47	.48	.12	836.07	88.89	88.89	83.54
scapula	514.27	3.01	.56	517.84	55.05	55.05	28.89
proximal humerus	323.08	11.38	8.19	342.65	36.43	36.43	55.58
distal humerus	323.08	16.39	2.61	342.08	36.37	36.37	48.69
proximal radius	161.02	16.46	3.18	180.66	19.21	28.62	41.81
distal radius	161.02	32.08	3.24	196.34	20.87	20.87	48.83
carpal	58.37	.48	3.33	62.18	6.61	15.21	42.54
proximal metacarpal	58.37	29.70	1.72	89.79	9.55	9.55	36.25
distal metacarpal	58.37	33.91	4.37	96.65	10.28	10.28	49.82
proximal femur	733.67	16.29	2.26	752.22	79.97	79.97	57.56
distal femur	733.67	23.63	12.00	769.30	81.79	81.79	100.00
proximal tibia	191.20	26.73	6.81	224.74	23.89	53.66	80.62
distal tibia	191.20	46.20	2.71	240.11	25.53	61.25	61.25
tarsal	70.41	.48	2.98	73.87	7.85	18.84	55.23
astragulus	70.41	.48	3.19	74.08	7.88	18.84	55.23
calcaneus	70.41	10.86	4.94	86.21	9.17	18.84	55.23
proximal metatarsal	70.41	41.89	2.05	114.35	12.16	12.16	49.22
distal metatarsal	70.41	48.00	4.63	123.04	13.08	13.08	64.27
first phalanx	31.21	14.47	4.62	50.30	5.35	5.35	31.61
second phalanx	31.21	10.61	3.01	44.83	4.77	4.77	22.24
third phalanx	31.21	.48	1.51	33.20	3.53	3.53	7.45

1. Meat Utility Index (Table 4.5)
2. Marrow Index (Table 4.6)
3. Grease Index (Table 4.7)

reasoning that:

> *The probabiltiy of a given part being assimilated to a part of higher value will increase as a function of the mean value between the two parts.* Where a given part has a low value but is anatomically between two parts of higher value, it would be assimilated to the part of highest value as a function of the mean of the general utility value of the adjacent parts of higher value (italics in original).

Close scrutiny of Binford's (1978:73, 74) Tables 2.6 and 2.7 shows that the above procedures were not followed by him in constructing sheep and caribou modifed general utility indices (MGUI). Instead, he first generated the proximal humerus MGUI by adopting the scapula general utility index (GUI). The MGUI for each successive front leg anatomical part was calculated by summing the preceeding anatomical part MGUI and the GUI of the part in question, and then dividing the total by 2.

In the rear leg, Binford increased the GUI value of the proximal femur to that of the distal femur. The anatomical part GUI values were used as MGUI values without additional modification in this case. The proximal tibia MGUI was calculated by Binford using the method he originally advocated. However, the MGUI for the distal tibia was created in the same manner described for the front limb elements. Tarsal, astragalus and calcaneus MGUI values were obtained from summing the distal tibia MGUI with the GUI for the distal metatarsal and dividing by 2. No transformation could be determined to replicate Binford's MGUI values for the carpals, proximal matacarpal, proximal metatarsal and distal metatarsal.

An approximated muskox modified general utility model (MGUM), based on the weight proportions of meat, marrow and grease, is presented in Table 6.1, col. 6. It was constructed by employing the method described by Binford. Therefore, those anatomical parts whose GUI values increased in response to the method actually used by Binford include: lumbar vertebra, proximal radius, carpals, proximal tibia, tarsals, astragalus and calcaneus.

Although Binford's conclusion that decisions regarding what anatomical parts to transport from kill-sites appears sound, the rationale to construct a weighted index is not entirely clear. An underlying assumption is that the Nunamiut consider quantity (weight proportions) the critical dimension for meat, marrow and grease acquisition. This assumption may not always be applicable, since other utility dimensions (eg. nutrition) may be more relevant than weight. In other words, weight proportions may not be the most appropriate dimension for characterizing a maximizing strategy with respect to general utility. Therefore, an additional modified utility model was constructed for muskoxen in which meat, marrow and grease values were assumed of equal importance in decision-making. The anatomical part values for individual food indexes were summed, divided by 3 and then standardized. The results are presented in Table 6.1, col. 7, and the relationship between the weighted and averaged models appears in Figure 6.1. The

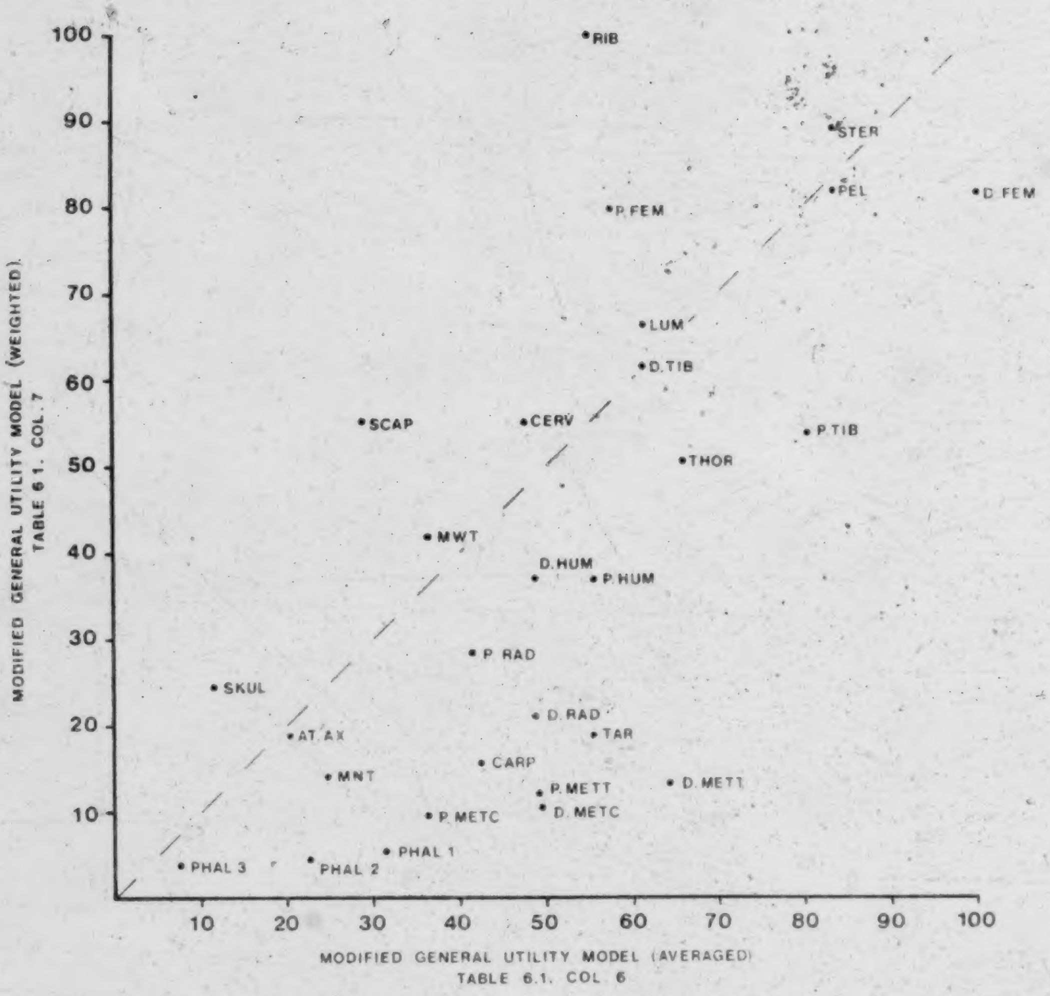


Figure 6.1 Relationship between weighted and averaged muskox general utility models.

figure shows that the proportional food value of appendicular parts is greater in the averaged model than in the weighted one. Axial anatomical part meat values are similar in both models; however, the averaged values of the skull and ribs are about one half that of their weighted values.

Of course, there are numerous permutations of the modified general utility model based upon the emphasis attributed to one or more of the food utility indices. The one which will be used for comparison with the anatomical part %MNI from the Copper Inuit archaeological sites is the averaged MGUM. No *a priori* decisions regarding the differential preference by weight of specific foodstuffs is made in this model. Even though the body weight of meat, marrow and grease differs, it is initially assumed that each food stuff has an equal opportunity of acquisition, based on relative variation in value existing among anatomical parts of a single food type, rather than that between food types. One way that variation between observed and expected %MNI for anatomical parts is then explained is in terms of Copper Inuit decision making regarding the differential value of meat, marrow and/or grease.

The last topic for discussion in this section concerns the level at which analyses were performed. Site, and intrasite examinations were undertaken by plotting the relationship between modeled and observed %MNI of muskox anatomical parts. This was accomplished with the scattergram subprogram provided in the Statistical Package for the Social Sciences (SPSS) (Nie et al. 1975). Intersite comparisons were also made.

At the site level, the entire bone assemblage was used as the analytical unit in order to derive a general picture of how muskoxen were procured and used. Areas of concentrated bone were the units of analysis in the investigation of intrasite variation regarding the use of carcass parts.

Bones are distributed unevenly over all three sites. It is readily apparent from observation of site maps generated with *PLOTLIB (a digital plotting routine; see Buttuls and Dembo 1977) that bone clusters can be delineated visually. SURFACE II (Sampson 1978), a computer contouring and graphics display system designed to contour fixed point data, was also employed to locate areas of dense bone.

It was initially assumed that each dense bone area represented the location where one or more subsistence related activities had been performed. The criterion for choosing the areas was that representative geographical coverage of the mapped site sample was acquired. Once the clusters were defined, they were then plotted onto maps containing stone feature locations. The physical proximity between activity areas and stone features, such as caches and tent rings, was identified in this manner. Often, there was no close association between a bone cluster and a feature. Although it could not be determined whether a bone cluster was created before, during or after the construction and use of a particular stone feature, contemporaneity was initially assumed. The potential temporal relationship was used as a point of departure for hypothesizing plausible relationships among the food value models and %MNI of anatomical parts tabulated from each cluster.

Haogak site analyses

Procurement

In general, animal procurement is contingent upon the hunter's knowledge of the prey species behavior. Behavioral variation exhibited among animals is frequently synchronized with changes in season. Therefore, in order to predict what kind of muskox procurement strategy was employed by Copper Inuit hunters around Haogak, it was necessary to know at what time of year animals were dispatched and during which season(s) the site was occupied. Analysis of dental annuli from 11 right, first mandibular molars collected at Haogak shows that animals were killed during the fall (see Savelle and Will 1982). In addition to faunal evidence for determining seasonality, structural evidence existed as well. As previously reported in Chapter Five, excavated floors in some PhPo-3 tent rings suggested fall occupation, because these structures probably functioned as cold traps.

In autumn, it would be feasible to procure a large number of muskoxen during any single hunting episode. This is because the animals frequently congregate into huge herds (see Chapter Three). For example, over 100 muskoxen are occasionally reported in fall herds which characteristically have a sex ratio approaching 1:1.

Alarmed animals usually exhibit one of two behavioral patterns. They may crowd together in a defensive circle, or flee as a group to the nearest high ground. Fall procurement of a large number of muskoxen already huddled in a defensive formation is a relatively easy task, as has previously been described. According to Jenness (1922:150), the practice of driving muskoxen towards or even onto campsites where hunters waiting in ambush could dispatch them was employed by the Copper Inuit. A topographical feature which would facilitate this type of hunting consists of a constricted pathway, such as a narrow valley, possessing limited access to areas of high ground. Camps could be pitched where hunters awaited the arrival of unsuspecting animals fleeing to elevated areas, or camps might be made in the vicinity of the kill-sites to reduce the enormous effort required to transport the large quantity of food suddenly available at group muskox kills.

The narrow valley below the Haogak site could have functioned as a corridor along which to drive muskoxen into the site vicinity. If this procurement strategy were practiced, then it is predicted that anatomical parts of low food utility would be present on Haogak in quantities greater than otherwise anticipated, that the axial and appendicular whole animal MNI would approximate a 1:1 ratio, demonstrating the presence of complete carcasses, and that the sex ratio as determined from skulls would correspond to a fall situation (1:1).

The frequency of low utility parts is considered in the section dealing with carcass use. Bone element counts, whole animal MNI and anatomical part MNI for the Haogak muskox bone assemblage appear in Table 6.2. The largest axial whole animal MNI is provided by the skull count which yields 75 individuals. This in itself is suggestive of a kill-site situation, because skulls have low food value and great weight (recall that the average weight of an adult male skull is 9.0 kg and that of an adult female skull is 2.6 kg). M'Clintock (1972:69) noted in 1857 that:

> I have been questioning Petersen about the bones of the musk oxen found in Smith's Sound; he says the decayed skulls of about twenty were found, all of them to the north of the 79th parallel. As they were all without lower jaws, he says they were killed by Esquimaux, who leave upon the spot the skulls of large animals...

None of the 75 crania had been broken open to extract the brains. However, many skulls were missing nasal bones suggesting that the nose had been removed and processed for consumption. Furthermore, the majority of skulls possessed intact horn sheaths, demonstrating that skulls were not collected for the purpose of acquiring this tool-making raw material.

The largest, appendicular whole animal MNI of 74 was derived from scapulae. Thus, the ratio of axial to appendicular whole animal MNI is remarkably close to the

Table 6.2
Minimum Number of Individuals Count for the Haogak Site Muskox Assemblage

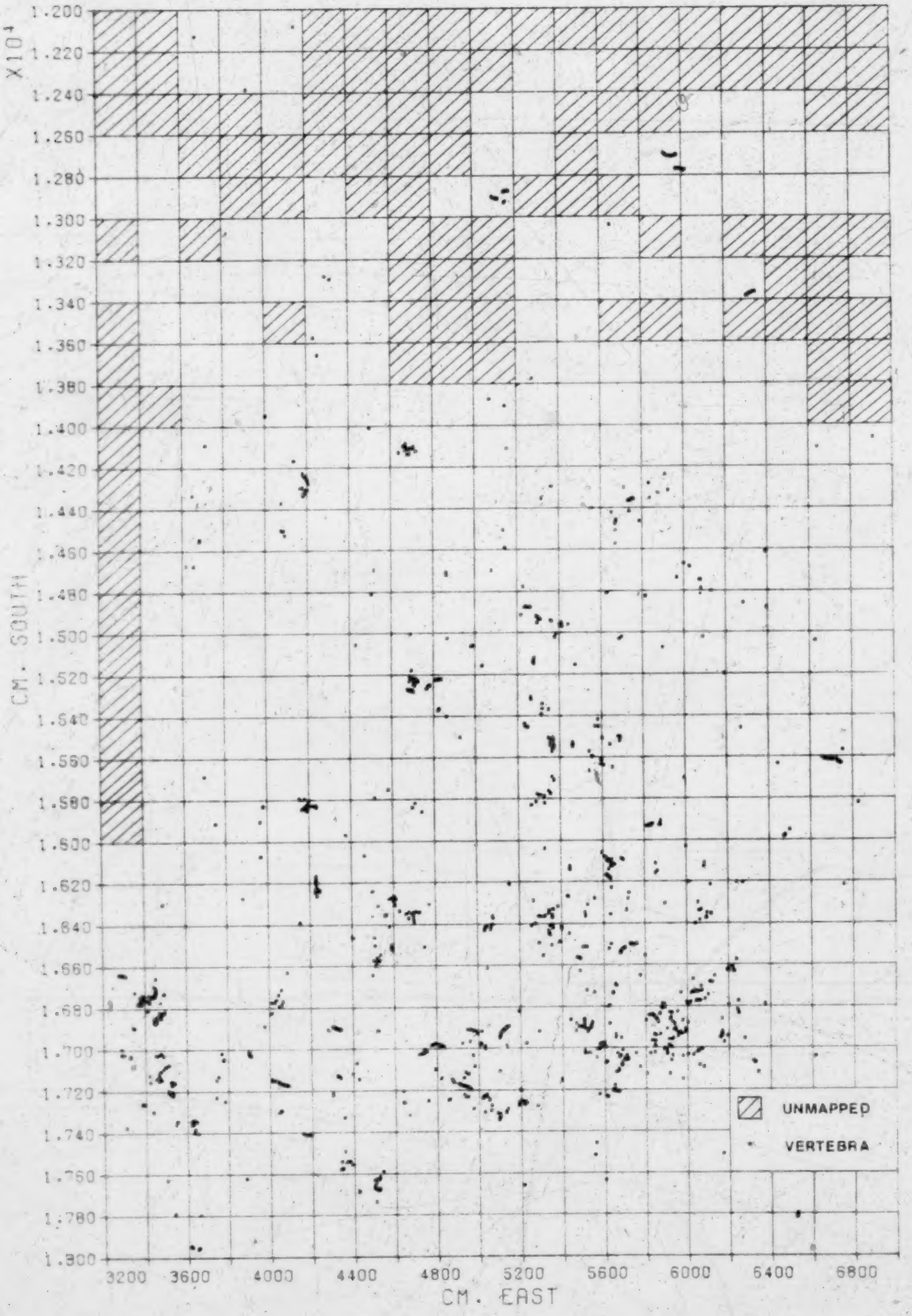
Anatomical Part	(1) Left	(2) Right	(3) Indet.	(4) Total	(5) Whole Animal MNI	(6) %	(7) Anatomical Part MNI	(8) %
Skull				75	75	100.00	75.0	100.00
Complete mandible	33	37	1	71	37	49.33	35.5	47.33
anterior fragment	52	47	13	112				
posterior fragment	58	47	12	117				
fragment	13	13	55	81				
Cervical vertebra				342	49	65.33	48.9	65.20
Thoracic vertebra				559	43	57.33	43.0	57.33
Lumbar vertebra				252	51	68.00	50.4	67.20
Indeterminate vertebra				81				
Complete pelvis	27	21	2	50	27		25.0	
incomplete pelvis	11	10	70	91	11	50.67	10.5	47.33
Complete scapula	67	69	4	140	70		70.0	
glenoid fossa	2	3	2	7	4	98.67	3.5	98.00
blade fragment	0	2	7	9				
Proximal humerus (fused)	3	1	0	4	3		2.0	
Proximal humerus (unfused)	2	0	0	2	2	6.67	1.0	4.00
Distal humerus (fused)	41	40	0	81	41		40.5	
Distal humerus (unfused)	3	2	0	5	3	58.67	2.5	57.33
Proximal radius (fused)	66	48	4	118	66		59.0	
Proximal radius (unfused)	0	0	0	0	0	88.00	0.0	78.67
Distal radius (fused)	15	13	4	32	16		16.0	
Distal radius (unfused)	6	6	1	13	7	44.00	6.5	36.00
Ulna	61	46	9	116	61	81.33	58.0	77.33
Proximal femur (fused)	12	16	0	28	16		14.0	
Proximal femur (unfused)	8	12	2	22	12	37.33	11.0	33.33
Distal femur (fused)	7	3	1	11	7		5.5	
Distal femur (unfused)	3	4	2	9	5	16.00	4.5	13.33
Proximal tibia (fused)	15	12	4	31	16		15.5	
Proximal tibia (unfused)	14	10	0	24	14	40.00	12.0	36.67
Distal tibia (fused)	43	53	1	97	53		48.5	
Distal tibia (unfused)	9	5	2	16	9	82.67	8.0	75.33
Proximal metapodial				50	13	17.33	12.5	16.67
Distal metapodial (fused)				110	28		27.5	
Distal metapodial (unfused)				21	6	45.33	5.25	43.67
Carpal				30	3		3.0	
Tarsal				42	7		7.0	
Astragulus	13	25	21	59	30	40.00	29.5	39.33
Calcaneus	23	30	3	56	30	40.00	28.0	37.33
Phalanx				24	1		1.0	
Rib or rib fragment				3542				
Longbone fragment				1642				

expected ratio of 1:1 for a kill-site. A total of 63 skulls could be sexed, and the ratio of 32 females to 31 males approaches the sex ratio observed in fall muskox herds.

Another indicator of whole carcass processing on the Haogak site is the presence of articulated sets of vertebrae. A total of 615 vertebrae with one or more articulations, and comprising 108 separate sets were recorded on PhPo-3. Four sets consisted of complete vertebral columns, 13 of them contained both cervical and thoracic vertebra, and 19 sets were composed of both thoracic and lumbar elements. The majority of the vertebral sets were distributed over the southern site portion, as illustrated in Figure 6.2.

The maturity index (MATI) was used to obtain a relative measure of the age structure of the Haogak muskox death assemblage. The method for calculating the MATI was described and explained in Chapter Four, and the relevant data for its calculation for the Haogak assemblage are presented in Table 6.3. An index of 13.8 was obtained for the assemblage. This score is at the upper end of the maturity scale (8-16).

If data were available on the sequence of long bone fusion in muskoxen, then a population profile broken down into age categories could be devised. It should be remembered, however, that the scant information available on muskox long bone fusion indicates that the proximal radius is the probable site of first fusion, and that this site


X10⁴
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1.720
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1.760
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CM. SOUTH
3200
3600
4000
4400
4800
5200
5600
6000
6400
6800
CM. EAST
▨ UNMAPPED
• VERTEBRA

Figure 6.2 Distribution of muskox vertebra on the Haogak site.

Table 6.3

Calculation of the Maturity Index (MATI) for the Haogak Site

Value	Prox. Humerus		Dist. Humerus		Prox. Radius		Dist. Radius		Prox. Femur		Dist. Femur		Prox. Tibia		Dist. Tibia		Total
	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	%
open(1)	2	40.0	3	6.8	0	0	7	30.4	12	42.9	5	41.7	14	46.7	9	14.5	223
closed(2)	3	60.0	41	93.2	66	100	16	69.6	16	57.1	7	58.3	16	53.3	53	85.5	1154[1]

Total % = 1377

Maturity Index (MI) = 13.8

1. percent total multiplied by closed value (2)

does not close until after the calf is 10 months old. Fused and unfused portions of all long bones except one, were present on PhPo-3. One hundred and eighteen proximal radii were identified and mapped, and all of them were fused (see Table 6.2). Therefore, every muskox represented in the archaeological assemblage possessed at least one closed long bone epiphysis. Because proximal radial fusion does not take place until after 10 months of age, calves born in the spring (April-May) would possess no fused long bones at the time of fall hunting. When these observations are considered in the context of muskox procurement in the vicinity of Haogak, it may be inferred that calves were intentionally not dispatched, or that young animals were not present in the herds exploited. There is no correlative support or justification for the former conclusion; remains of young muskoxen are found on both the Nasogaluak and Kuptana sites.

On the other hand, calving failure in response to severe winter conditions is documented, and has already been discussed in Chapter Three. This event may have occurred in the region around Haogak during its occupation in the 19th century. Unfortunately, no meteorological readings exist to either support or refute this hypothesis, but the significance of its plausibility is entertained in Chapter Seven.

Use

Haogak is an interesting site from the perspective of muskox use, because it contains both a substractive (kill-site) and additive (habitation) faunal assemblage. Some form of the modified general utility model should be appropriate for predicting the composition of the site muskox bone assemblage. This is because the cumulative consequences of carcass processing across the site should have resulted in anatomical part frequencies reflecting the maximal use of meat, marrow and grease. However, because PhPo-3 is also a kill-site at which low food utility parts were discarded, bone elements from those carcass portions should be present in frequencies greater than expected with the model.

The MGUM is designed to predict decisions made by assessing the overall food value of carcass parts; in other words it models the composition of faunal assemblages in a "systemic context" (Schiffer 1972:157). The Haogak bone assemblage is the residue of food processing activities; it represents the product of human activity in the archaeological context. Therefore, food processing behaviors which cause destruction of bones create problems for interpreting archaeological data with systemically derived models. Bone is not destroyed when anatomical parts are processed for meat. Although diaphyseal bone breakage happens during marrow extraction, damage to diagnostic morphological features (eg. on epiphyses) is nonexistent or minimal. In contrast, grease production results in substantial destruction to bone ends, because they are smashed into tiny fragments and then boiled to obtain their fat.

In order to compensate for the discrepancy between the systemic and archaeological contexts, the average MGUM was multiplied by the inverse of the grease index (Table 6.4, col. 1) and standardized. It was reasoned that the inverse GI measured the relative percent of bone elements destroyed after a grease processing episode. Therefore, bones which possess high grease value, as well as high values for other foodstuffs would still occur in low percentages in archaeological sites where grease extraction took place. The relationship between the archaeological MGUM (MGUM x inverse grease) and the anatomical part %MNI for the Haogak muskox bone assemblage is shown in Figure 6.3. It contradicts an earlier prediction that low utility parts would be present in numbers greater than indicated by their general food value. Most elements occur in percentages less than anticipated by the model. Part of the disparity may be due to marrow processing at Haogak which far exceeded the anatomical part frequencies modeled with the muskox marrow index. It was reported in the site description (Chapter Five) that all muskox long bones were broken as a consequence of marrow processing.

Provided that the Haogak site was also a kill-site, transportation of muskox carcasses was not necessary. This made marrow bones, even those associated with parts of low meat utility, abundantly available. This fact, considered with Jenness' (1922:103) comment that the Copper Inuit

Table 6.4

Food Utility Models for Examining the Archaeological Context

Anatomical Part	(1) grease inverse	(2) standardized archaeological MGUM	(3) standardized meat+marrow	(4) standardized meat+grease	(5) standardized marrow+grease
skull	100.00	17.54	10.42	15.28	1.09
mandible	92.46	52.79	39.97	56.67	16.85
cervical vertebra	87.84	65.18	44.01	73.54	12.57
thoracic vertebra	90.94	93.76	40.23	67.16	9.94
lumbar vertebra	88.83	85.44	28.54	51.48	11.74
pelvis	76.58	100.00	70.66	100.00	26.64
scapula	95.33	43.02	47.91	70.55	11.33
proximal humerus	31.76	27.58	45.63	40.61	31.75
distal humerus	78.29	59.55	53.82	54.72	47.53
proximal radius	73.53	48.03	40.40	39.95	48.58
distal radius	72.99	55.68	65.96	40.15	74.47
proximal femur	81.16	72.97	87.98	97.99	46.55
distal femur	00.00	1.56	100.00	2.22	1.67
proximal tibia	43.25	54.47	59.73	41.55	52.86
distal tibia	77.39	74.05	91.59	41.44	100.00
astragulus	73.44	63.36	6.66	31.16	22.00
calcaneus	58.82	50.74	23.66	35.67	40.79
proximal metapodial	84.30	56.27	63.97	23.68	82.74
distal metapodial	62.52	55.71	72.41	34.53	83.47

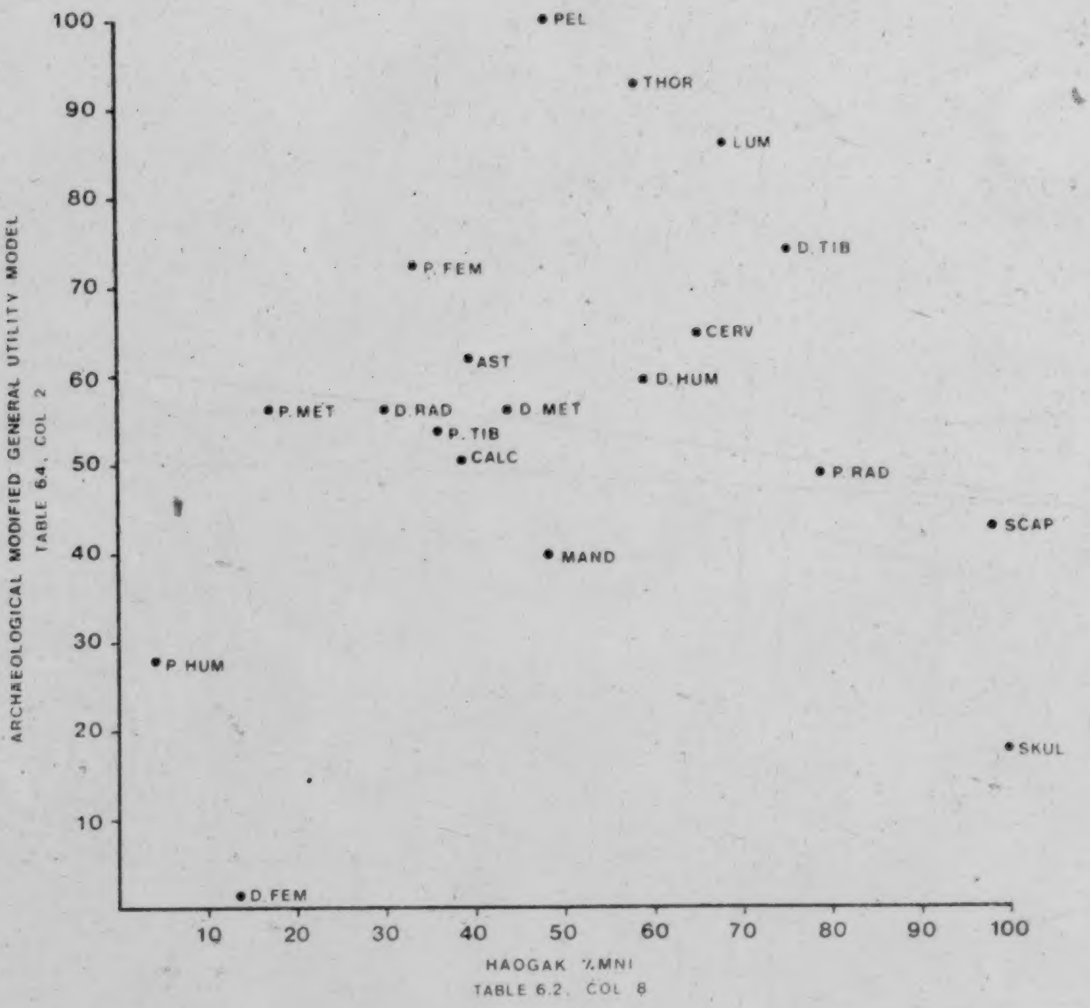


Figure 6.3 Relationship between the archaeological muskox general utility model and the %MNI from the Haogak muskox assemblage.

valued marrow as a delicacy, goes far in explaining why a model based on the amount of marrow available for extraction from every anatomical part is too simplistic for this site analysis. This situation suggested that the Haogak muskox anatomical part %MNI should be compared with the meat, marrow, and grease models independently.

Not surprisingly, the majority of elements occurred in much higher percentages than were predicted with either the meat or marrow models. When the anatomical part %MNI were compared with inverse values of the grease model, a relatively linear relationship (r=.67, p=.001) was obtained (see Figure 6.4). At the site level, it appears that grease processing was practiced in a manner similar to what was anticipated with the grease model, although bones with high grease utility were processed even more often than predicted with a simple linear relationship. The Copper Inuit are also known to have placed an extraordinary high value on bone grease, perhaps regarding it as their most esteemed food (Jenness 1922:103). Grease manufacture at Haogak helps to explain some characteristics of the muskox bone assemblage.

Intrasite analysis

The view from the site level does not necessarily prescribe what is to be expected from intrasite bone assemblages. This is because variation which inevitably occurred in muskox use across the site is obscured by the generalized picture. Nine concentrations of muskox bones varying in size and density were selected to examine

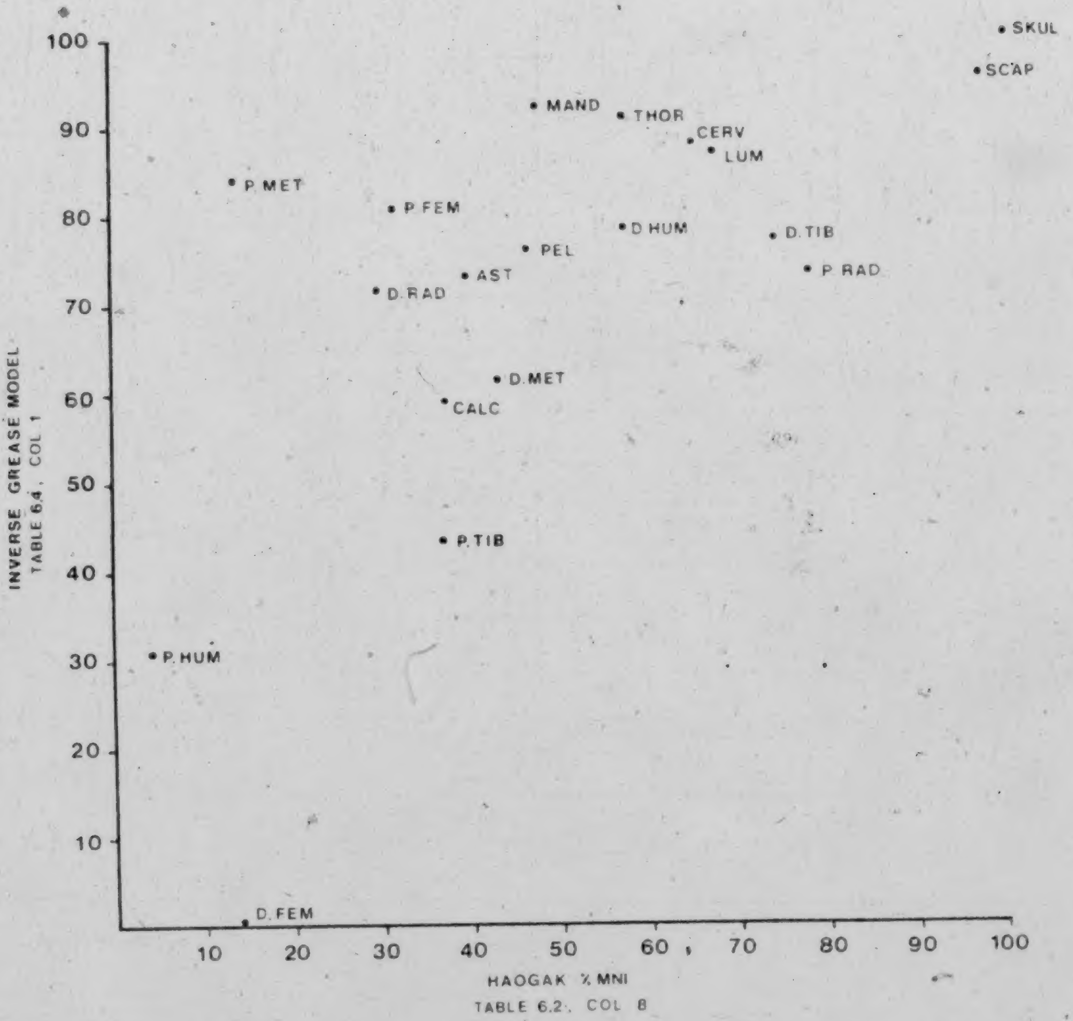
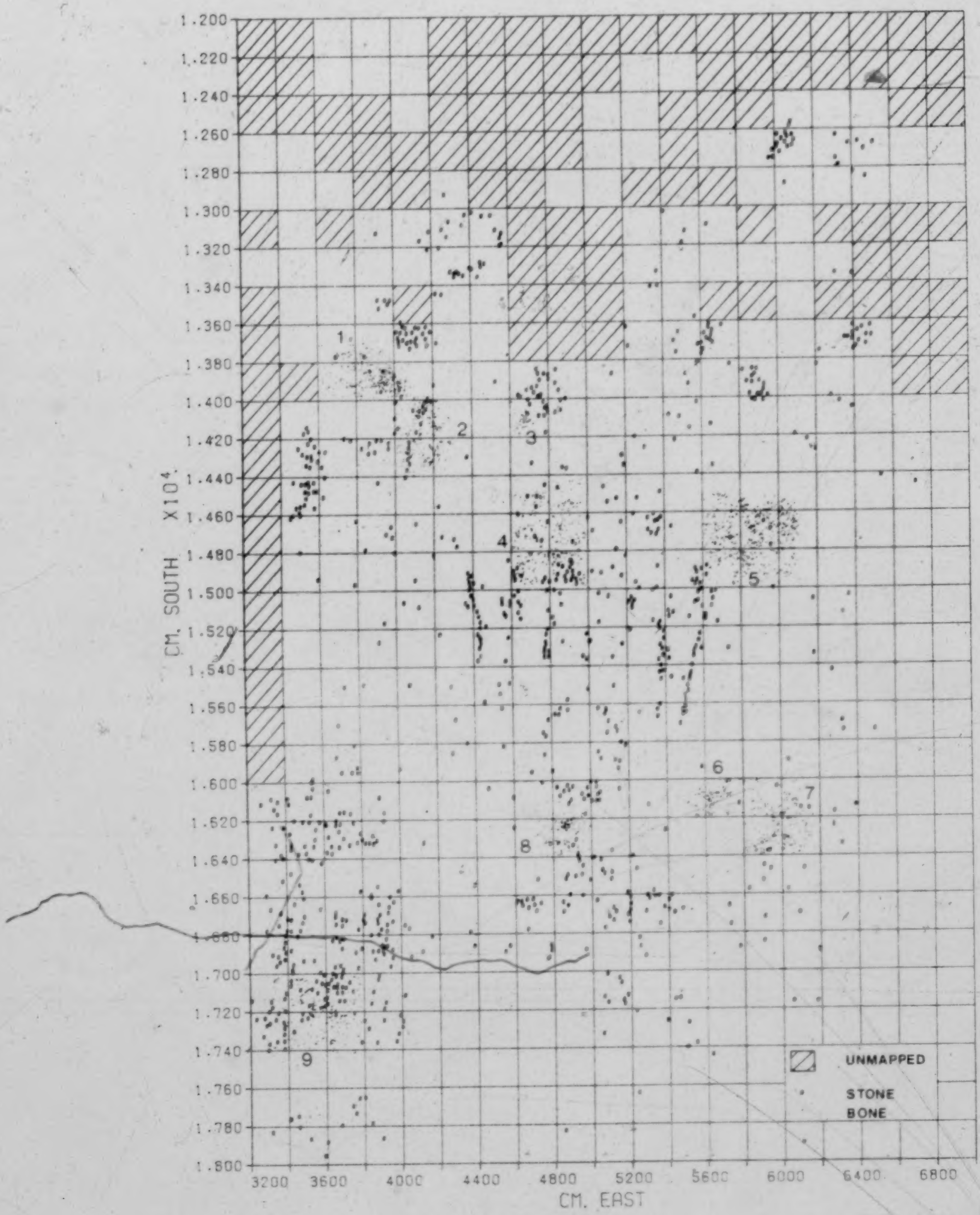


Figure 6.4 Relationship between the grease inverse model and the %MNI from the Haogak muskox assemblage.

intrasite differences in carcass use. It was initially assumed that these concentrations represented activity areas where food processing, consumption, and/or disposal took place so that the %MNI of anatomical parts derived from them could be compared with the food use models.

The distribution of the nine PhPo-3 bone concentrations, and their proximity to stone features is shown in Figure 6.5. Information concerning their exact provenience, size, number of specimens and bone density is presented in Table 6.5. The number of square meters covered by each concentration varied between 4 and 25. Bone density was as low as 6.1 specimens/m^2 and as high as 18.4 specimens/m^2. Five of the areas were directly associated with stone features including: caches (nos. 1 and 9), stone rows (nos. 2 and 9) and tent ring entrances (nos. 3 and 8). Anatomical part tabulations, MNI and %MNI for each activity area are displayed in Table 6.6.

This discussion will proceed with an examination of those areas not in immediate proximity to stone features. The absence of stone features made it difficult to propose any specific functional hypotheses for activity areas 4, 5, 6, and 7. One or more of the areas may have been locations where bones were collected and processed for grease. Some might contain bone accumulations discarded after the simultaneous processing for 2 or more foodstuffs. Consequently, any one of the food utility models might satisfactorily predict the %MNI of anatomical parts in these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CM. SOUTH X10⁴
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4400
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5200
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6000
6400
6800
CM. EAST
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3
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5
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7
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9
UNMAPPED
STONE
BONE

Figure 6.5 Bone concentrations and stone features on the Haogak site.

Table 6.5

Summary Characteristics of Haogak Activity Areas

Activity area	Xmin	Xmax	Ymin	Ymax	Assoc. features	Area	No. of bones	Bone density/ square meter
1	036	041	137	140	cache	15	276	18.4
2	040	043	140	144	stone row	12	182	15.2
3	046	048	140	142	tentring entrance	4	36	9.0
4	046	050	144	150	none	24	265	11.0
5	056	061	145	150	none	25	414	16.6
6	055	058	160	162	none	6	98	16.3
7	058	062	160	164	none	16	190	11.9
8	047	050	161	164	tentring entrance	9	122	13.6
9	033	038	170	175	cache, stone row	25	152	6.1

Table 6.6

Anatomical Part Counts from Haogak Activity Areas

Anatomical part	No.	(1) MNI	%MNI	No.	(2) MNI	%MNI	No.	(3) MNI	%MNI
skull	0	0	0	0	0	0	0	0	0
mandible	1	.50	33.33	0	0	0	0	0	0
cervical	0	0	0	8	1.14	100.00	7	1.00	100.00
thoracic	0	0	0	13	1.00	87.72	8	.62	62.00
lumbar	2	.40	26.67	4	.80	70.18	0	0	0
pelvis	1	.50	33.33	2	1.00	87.72	0	0	0
scapula	3	1.50	100.00	1	.50	43.86	1	.50	50.00
proximal humerus	0	0	0	0	0	0	0	0	0
distal humerus	0	0	0	2	1.00	87.72	0	0	0
proximal radius	0	0	0	1	.50	43.86	0	0	0
distal radius	0	0	0	0	0	0	0	0	0
proximal femur	1	.50	33.33	0	0	0	0	0	0
distal femur	1	.50	33.33	0	0	0	0	0	0
proximal tibia	1	.50	33.33	0	0	0	0	0	0
distal tibia	1	.50	33.33	2	1.00	87.72	0	0	0
proximal metapodial	0	0	0	1	.25	21.93	0	0	0
distal metapodial	3	.75	50.00	4	1.00	87.72	0	0	0
astragulus	0	0	0	0	0	0	0	0	0
calcaneus	0	0	0	0	0	0	0	0	0
long bone frag.	235			120			14		

Table 6.6 Continued

Anatomical Part Counts from Haogak Activity Areas

Anatomical part	No.	(4) MNI	%MNI	No.	(5) MNI	%MNI	No.	(6) MNI	%MNI
skull	0	0	0	1	1.00	20.00	1	1.00	76.92
mandible	1	.50	33.33	7	3.50	70.00	0	0	0
cervical	0	0	0	1	.14	4.00	9	1.30	100.00
thoracic	0	0	0	6	.46	13.14	9	.69	53.08
lumbar	0	0	0	2	.40	11.43	0	0	0
pelvis	2	1.00	66.67	1	.50	10.00	2	1.00	76.92
scapula	2	1.00	66.67	10	5.00	100.00	0	0	0
proximal humerus	0	0	0	0	0	0	0	0	0
distal humerus	3	1.50	100.00	1	.50	10.00	1	.50	38.46
proximal radius	3	1.50	100.00	7	3.50	70.00	0	0	0
distal radius	2	1.00	66.67	3	1.50	30.00	0	0	0
proximal femur	0	0	0	1	.50	10.00	0	0	0
distal femur	0	0	0	0	0	0	0	0	0
proximal tibia	1	.50	33.33	3	1.50	30.00	1	.50	38.46
distal tibia	3	1.50	100.00	5	2.50	71.43	1	.50	38.46
proximal metapodial	1	.25	16.67	1	.25	5.00	0	0	0
distal metapodial	4	1.00	66.67	6	1.50	30.00	0	0	0
astragulus	0	0	0	1	.50	10.00	1	.50	38.46
calcaneus	1	.50	33.33	1	.50	10.00	1	.50	38.46
long bone frag.	265			414			98		

Table 6.6 Continued

Anatomical Part Counts from Haogak Activity Areas

Anatomical part	No.	(7) MNI	%MNI	No.	(8) MNI	%MNI	No.	(9) MNI	%MNI
skull	0	0	0	1	1.00	66.67	1	1.00	24.15
mandible	1	.50	20.00	3	1.50	100.00	0	0	0
cervical	3	.60	24.00	2	.29	19.33	29	4.14	100.00
thoracic	7	.54	21.60	0	0	0	31	2.38	57.49
lumbar	6	1.20	48.00	0	0	0	5	1.00	24.15
pelvis	0	0	0	1	.50	33.33	1	.50	12.08
scapula	0	0	0	2	1.00	66.67	1	.50	12.08
proximal humerus	0	0	0	0	0	0	0	0	0
distal humerus	2	1.00	40.00	1	.50	33.33	2	1.00	24.15
proximal radius	5	2.50	100.00	0	0	0	7	3.50	84.54
distal radius	0	0	0	1	.50	33.33	0	0	0
proximal femur	1	.50	20.00	0	0	0	1	.50	12.08
distal femur	0	0	0	0	0	0	2	1.00	24.15
proximal tibia	2	1.00	40.00	1	.50	33.33	1	.50	12.08
distal tibia	1	.50	20.00	3	1.50	100.00	5	2.50	60.39
proximal metapodial	0	0	0	1	.25	16.67	3	.75	18.12
distal metapodial	0	0	0	4	1.00	66.67	5	1.25	30.19
astragulus	0	0	0	0	0	0	2	1.00	24.15
calcaneus	0	0	0	0	0	0	1	.50	12.08
long bone frag.	115			81			26		

activity areas.

The relationship between the %MNI of bone elements in the areas was independently tested with seven food utility models. The models included: meat, marrrow, grease inverse, archaeological MGUM, meat+marrow, meat+grease, and marrow+grease. Models one through four have been previously described. The last three appear in Table 6.4, cols. 3, 4, and 5, respectively. Combination models were constructed in the same manner as the MGUM - anatomical part values were summed, averaged and then standardized. Those which involved the production of bone grease were multiplied by grease inverse values and then standardized to accomodate expectations for the archaeological context.

There were no close fits between any of the food use models and the %MNI of anatomical parts from the four bone concentrations except in one case. The relationship between the marrow+grease model and the %MNI of parts from area 4 was roughly linear (r=.56, p=.05). The conclusion that marrow processing occurred at this location is also supported by the presence of a large quantity of long bone diaphyseal fragments (201) which would have been created when long bones were smashed open.

Other relationships showed up repeatedly, however. High value food parts (regardless of which food stuff was considered) tended to occur in numbers less than anticipated, whereas low value food parts were proportionally more frequent than expected in the areas.

This observation supports the hypothesis that areas 4, 5, 6, and 7 were generalized disposal locations where discarded bones from one or more processing activities were eventually deposited.

Two bone concentrations occurred at the entrances to tent rings. Area 8 was centrally located on the site, and area 3 was approximately 20 meters north of it (see Figure 6.5). If these activity areas had been created during the occupation of the tent rings, it was hypothesized that the %MNI of muskox bones in them would bear a relationship with the meat, marrow and/or meat+marrow models. Grease processing may have been a collective effort which took place away from individual residences, because it entailed gathering a sufficient number of bones to make the extraction process practical and efficient.

Alternatively, the food use models as they are developed here may be totally inadequate predictors of bone frequencies in activity areas 3 and 8, because of the initial large size of the food package (complete muskox carcasses) (see Binford 1978:472), the number of families sharing food, and the nature of social relationships involved in food distribution among households. An individual muskox carcass possesses more food than can be immediately consumed by members of an average sized nuclear family. Among the Nunamiut, large food inputs into the community are divided into smaller packages which are shared among villagers.

Food sharing was an important component of Copper Inuit social organization. It was not dependent upon kinship affiliation, as was characteristic of other Inuit groups (Damas 1972). Instead, sharing partnerships (*piqatiglit*) were arranged among non-kin, as well as kin, for the division of seal in winter villages. According to Damas (1972:24):

> Fourteen major parts of the seal were designated, and each was represented by an individual who would receive that part from successful partners. When the seal was hauled home the partitioning took place in the house of the successful hunter, and children from each partner's immediate family received the designated share in a skin bucket and carried it home...

No information is available that documents whether or not this social practice was transferred to the division and consumption of terrestrial mammal carcasses in spring, summer and fall camps. These camps were generally smaller than winter ones, and shorter-lived. The archaeological data are too imprecise to determine length of stay or number of families present at any particular time at any of the three Copper Inuit sites. If the social obligation of food sharing did continue through spring, summer and fall, then muskox anatomical parts might be differentially distributed among tent-rings. Bone frequencies in assemblages would reflect social commitments rather than food utility value.

Area 3 exclusively contained thoracic and cervical vertebrae, a single scapula and a few long bone diaphyseal fragments (14). The fragments imply that some marrow bones had been processed, but that they had been removed from the area. The meat utility index is greater than 50% for all three elements present. In contrast, marrrow and grease values are quite low for the scapula, and the cervical and thoracic vertebrae. None of these bones had been processed for either food stuff.

The tent ring associated with area 8 is one of the largest on the site, and it measured about 4.5 meters in diameter. Bone fragments totaled 81, suggesting that marrow processing was performed. No distinct patterning or clustering was found between the food utility models and the %MNI of skeletal parts in area 8. However, this is in part due to the absence of certain bones; those elements and element portions which are present do exhibit a relationship between their %MNI and the meat+marrow model (see Figure 6.6).

Parts which are not present in the assemblage are the proximal and distal femur, thoracic and lumbar vertebrae, astragalus, calcaneus, proximal radius and proximal humerus. The absence of these particular bones may be spurious; however, it may be indicative of food sharing practices which the specific models developed in this investigation were not designed to take into consideration.

Stone rows varying between 3 and 7 meters long are unique to Haogak among the three sites analyzed. They occur singly or in groups, and are oriented north to south (refer to Figure 6.5). There are no ethnographic analogs for these features, and their purpose remains undetermined. Activity

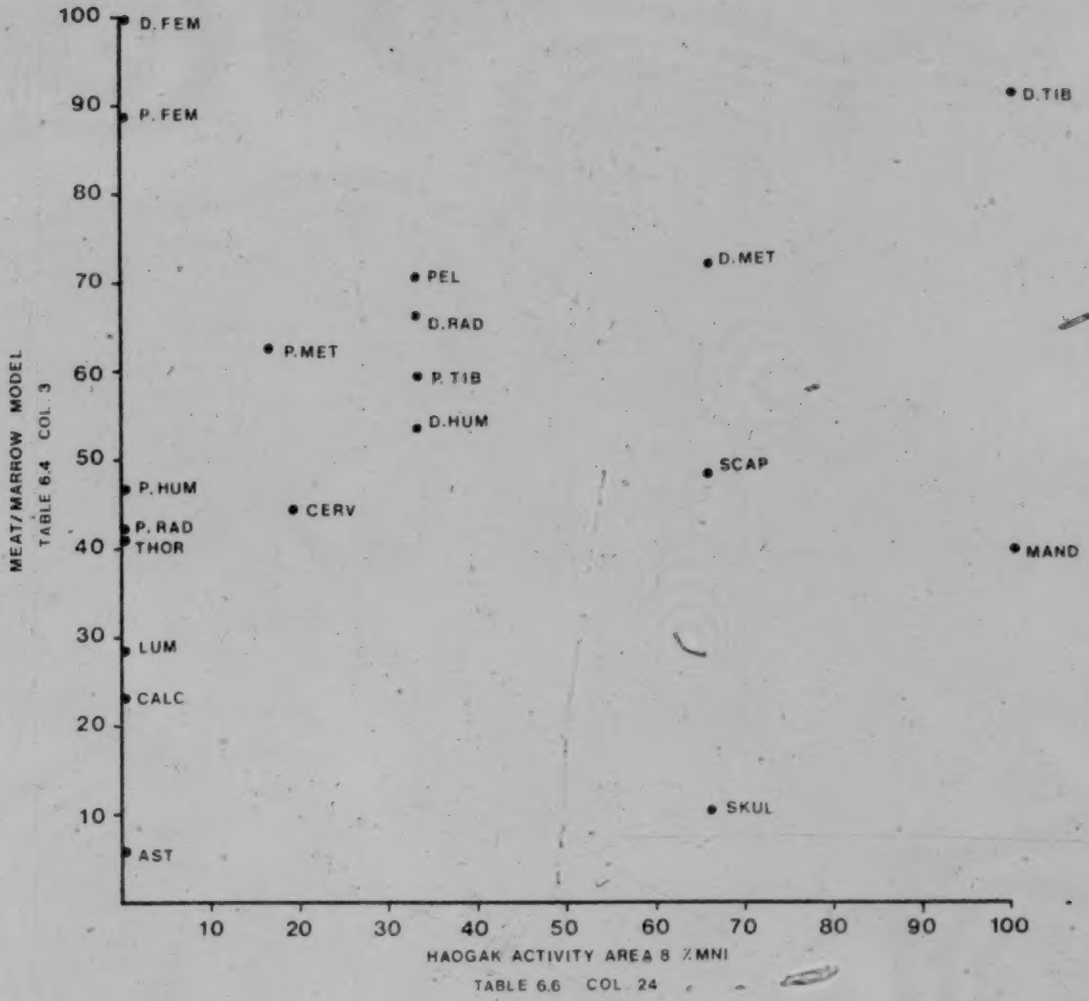


Figure 6.6 Relationship between the meat+marrow model and the %MNI from Haogak activity area 8.

areas 2 and 9 contain bone concentrations clustered around two stone rows present at either site end. A cache feature is situated beside the stone row at the southern end of PhPo-3, where activity area 9 is located.

No hypotheses were made about which food utility models would be appropriate to examine the %MNI of anatomical parts in areas 2 and 9. Therefore, the same set of models used to examine areas 4, 5, 6 and 7 was employed. Area 2 showed a relationship with the archaeological general utility model. The accumulation of bones in this area may have resulted from the simultaneous and/or cumulative processing for meat, marrow and grease. Meat bones low in marrow and grease predominate in the assemblage. A total of 120 long bone diaphyseal fragments suggest that marrow processing occurred, despite the fact that proximal humerii, distal radii, femora and proximal tibiae are not present in Area 2.

Activity area 9 anatomical part %MNI closely approximate the %MNI of bones in those concentrations hypothesized to be disposal areas, especially numbers 6 and 7. That is to say, high food value bones are generally less frequent than expected, whereas bones belonging to anatomical parts with low food utility are more common than anticipated. Findings for either activity area lend no additional clues for explaining the function of stone rows.

Caches are the last type of stone feature found proximate to one or more of the bone concentrations. Area 1 is situated beside a cache at the north end of the site; the possible association of area 9 and a cache has already been noted. Presumably, muskox meat was placed in caches in anticipation of future use. Drying beforehand would not have been necessary, because cool autumn temperatures would have created conditions for refrigeration. It is not known whether meat was removed from bones before storage, although Jenness (1922) reported that marrow bones were cached (see Chapter Two).

This situation suggests that the meat and marrow models or a combination of them might accurately predict the %MNI of bones in area 1. In fact, they do not. Front limbs are entirely missing from the assemblage. This location produced the largest number of long bone diaphyseal fragments (235) indicating that marrow processing of perhaps a large number of limb elements had occurred. It is possible that meat was prepared for storage by deboning, and that bones were processed immediately for marrow and then accumulated elsewhere for grease extraction. However, it is equally plausible that the area 1 bone assemblage was not created in response to the use history of the cache, and that it simply represents another disposal area of discarded parts.

In summary, %MNI of muskox skeletal parts in the Haogak faunal assemblage closely resemble values predicted with the inverse grease model. Grease extraction from long bone ends based on a maximization strategy appears to have been an important activity at this site.

Variation in the intrasite use of muskox carcass parts exists; however, the food utility models frequently do not accurately predict the %MNI of anatomical parts in activity areas. Lack of correspondence can be attributed to several possibilities. First, the combination models may not realistically reflect relative value attributed to different foods stuffs. Second, a functional relationship does not necessarily exist between stone features and bone concentrations. Third, and perhaps of primary importance, is that these models are insufficient for predicting the nature of zooarchaeological assemblages that were structured by social activities such as food sharing. Decisions concerning the distribution of muskox parts among participants in a food sharing partnership may have little or no dependency on food value measured in terms of relative weight.

However, the food utility models do provide a starting point for measuring and interpreting variation in zooarchaeological assemblages. Differences between expected and observed %MNI of muskox anatomical parts offer clues for determining why certain kinds of patterning occur in the Haogak record of animal use. For example, activity areas 4, 5, 6 and 7 all show similarities in the high frequency of parts possessing low food utility. This characteristic may be a signature pattern for disposal areas.

Few caches are present on PhPo-3, and their rarity may mean that food consumption was more or less immediate. As it was reported in Chapter Five, a row of stone caches does exist between the site and the coast. No bones were present among them, and their proximity to the shoreline suggests that they were used to store seal blubber in the spring. In autumn, Copper Inuit families returned to the coast from their summer hunting camps. They met at various predetermined locations to wait and prepare for winter sealing in Prince of Wales Strait. Haogak may be one of these locations, where a group of families resided for one or two months before moving out onto the sea ice. A large amount of food would be required to sustain the community during the waiting period. Exploitation of large muskox herds whose meat, marrow and grease would have provided a reliable food resource in an area otherwise lacking large mammals would have satisfied this need.

Nasogaluak site analyses

Procurement

The Nasogaluak site (PgPw-3) occurs in a different topographic setting than Haogak. Most of the region surrounding it consists of floodplain characterized by very little relief. The open environment offers little or no opportunity for hunters to approach muskoxen without being observed, or to drive animals along predetermined routes. Flight direction of frightened animals would be difficult to predict.

In addition to topographical dissimilarities between the two site settings, there are also seasonal differences in site use. Spring and/or summer muskox procurement occurred at Nasogaluak, as established by my analysis of dental annuli from 10 right first molars collected there. Spring hunting is corroborated by the presence of bones which belonged to very young muskoxen. Comparison with skeletal elements from a 3 month old calf suggests that the immature PgPw-3 specimens belonged to even younger individuals.

Solitary bulls are more common during spring and summer. The winter herds disperse into summer groups consisting of females with calves, and single sexed herds of immature animals (refer to Chapter Three). This circumstance means that Copper Inuit hunters were probably unable to procure a large number of animals during any single hunt. The ease with which muskoxen could have escaped from approaching hunters also suggests that animals may not often have been killed near Nasogaluak.

Expectations regarding the Nasogaluak bone assemblage are different than those predicted for Haogak. Unlike Haogak, the whole animal MNI ratio of axial to appendicular parts should be biased strongly in favor of the latter. Bone element counts, whole animal MNI, and anatomical part MNI for the PgPw-3 osteological assemblage are displayed in Table 6.7.

The largest axial MNI is 7, and it is provided by the lumbar vertebrae. Only five skulls were counted in the site bone sample. In contrast, 89 animals must have been

Table 6.7
Minimum Number of Individuals Count for the Nasogaluak Site Muskox Assemblage

Anatomical Part	(1) Left	(2) Right	(3) Indet.	(4) Total	(5) Whole Animal MNI	(6) %	(7) Anatomical Part MNI	(8) %
skull				5	5	5.62	5.0	5.76
complete mandible	15	17	0	32	17	19.10	16.0	18.44
anterior fragment	52	73	8	133				
posterior fragment	51	52	2	105				
fragment	0	0	187	187				
cervical vertebra				16	3	3.37	2.3	2.65
thoracic vertebra				58	5	5.62	4.5	5.19
lumbar vertebra				32	7	7.87	6.4	7.38
indeterminate vertebra				11				
complete pelvis	3	0	1	4	3		2.0	
incomplete pelvis	3	3	43	49	3	6.74	3.0	5.76
complete scapula	33	30	1	64	33		32.0	
glenoid fossa	2	1	0	3	2	39.33	1.5	38.62
blade fragment	2	3	8	13				
proximal humerus (fused)	8	6	1	15	8		7.5	
proximal humerus (unfused)	5	7	1	13	7	16.85	6.5	16.14
distal humerus (fused)	62	78	1	141	78		70.5	
distal humerus (unfused)	9	10	3	22	11	100.00	11.0	93.95
proximal radius (fused)	46	71	4	121	71		60.5	
proximal radius (unfused)	4	5	2	11	6	86.52	5.5	76.08
distal radius (fused)	29	21	3	53	29		26.5	
distal radius (unfused)	7	10	4	21	11	44.94	10.5	42.65
ulna	47	62	7	116	62	73.03	58.0	66.86
proximal femur (fused)	27	19	0	46	27		23.0	
proximal femur (unfused)	9	17	5	31	17	49.43	15.5	44.38
distal femur (fused)	8	17	1	26	17		13.0	
distal femur (unfused)	10	9	0	19	10	30.34	9.5	25.94
proximal tibia (fused)	28	18	1	47	28		23.5	
proximal tibia (unfused)	8	9	2	19	10	42.70	9.5	38.04
distal tibia (fused)	67	56	2	125	67		62.5	
distal tibia (unfused)	7	12	7	26	13	89.89	13.0	87.03
proximal metapodial				88	22	24.72	22.0	25.36
distal metapodial (fused)				226	57		56.5	
distal metapodial (unfused)				121	31	96.63	30.25	100.00
carpal				47	5		4.7	
tarsal				69	12		11.5	
astragulus	11	25	44	80	40	44.94	40.0	46.11
calcaneus	32	51	3	86	51	57.30	43.0	49.57
phalanx				156	7		6.5	
rib or rib fragment				497				
longbone fragment				3360				

dispatched in order to produce the quantity of distal humerii recorded. The ratio of axial to appendicular MNI roughly equals 1:13 and supports the proposition that most muskoxen were dispatched away from Nasogaluak. Meat would have been removed from those carcass portions containing heavy axial bones (coincidentally, those low in marrow and grease) perhaps in a similar fashion to that practiced by prehistoric Plains bison hunters (see Frison 1978).

Other support for the practice of this procurement method is derived from muskox kill-sites in the region around Nasogaluak. The composition of each kill-site was not specifically recorded, but those observed by the writer consisted exclusively of axial skeletal parts, ribs and pelves. Recall the example of one kill-site consisting of the remains of two bulls (illustrated in Figure 5.4).

A population maturity index was calculated for Nasogaluak, and the relevant data are included in Table 6.8. A MATI of 13.9 was derived, and like the Haogak index, it is also at the older end of the maturity scale. In contrast to PhPo-3, however, unfused proximal radii were present on Nasogaluak. They constituted 8% of the whole animal MNI for that element portion. Therefore, 8% was subtracted from the MNI percentage of each unfused long bone portion, because no other long bone epiphyses would have been closed among the immature muskoxen with unfused proximal radii. The revised percentages were summed and added to the closed value totals. A new MATI was calculated by dividing the revised

Table 6.8

Calculation of the Maturity Index (MATI) for the Nasogaluak Site

Value	Prox. Humerus		Dist. Humerus		Prox. Radius		Dist. Radius		Prox. Femur		Dist. Femur		Prox. Tibia		Dist. Tibia		Total
	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	%
open(1)	7	46.7	11	12.4	6	7.8	11	27.5	17	38.6	10	37.0	10	26.3	13	16.2	212.5
closed(2)	8	53.7	78	87.6	71	92.2	29	72.5	27	61.4	17	63.0	28	73.7	67	83.8	1175.0[1]

Total % = 1387.5

Maturity Index = 13.9

1. percent total multiplied by closed value (2)

grand total by 92 (100%-8%), and it resulted in a maturity index of 14.4 for the PgPw-3 muskox skeletal assemblage that included animals with one or more fused long bone epiphyses.

The removal of very young muskoxen from the site sample makes the Nasogaluak MATI directly comparable to the Haogak one. The difference between the indices suggests that muskoxen procured in the Nasogaluak region were slightly older (collectively) than around the coastal site. This conclusion is used as further support for hypothesizing that spring and summer animal exploitation occurred during which solitary bulls or adult individuals separated from fleeing herds were more frequently procured than entire herds of mixed age animals. Another interpretation which has been suggested by Hickey (pers. comm. 1984) is that herds with young were less easily approached than were single and/or more mature groups without calves. Hunting success as conditioned by this behavioral factor resulted in the high MATI at Nasogaluak.

Use

Based on the reconstructed procurement strategy, Nasogaluak represents an additive assemblage, in that muskox carcass parts were introduced from elsewhere. It contains a bone assemblage from which elements have previously been culled. Meat removal from heavy axial elements was likely performed at kill-sites in order to lessen transport weight of food to camp. Weighed archaeological vertebrae show that the vertebral column of an adult muskox is over 7.0 kg.

These bones, like the skull, have very low marrow and grease utility (see Tables 4.6 and 4.7). Therefore, analyses were restricted to examining the relationship between observed and modeled food values for a subset of anatomical parts. Skulls, vetebrae, and pelves are not included in the reconstruction of carcass use at Nasogaluak, because it is inferred that these elements were usually abandoned at primary butchering sites (see Table 6.7 indicating their extreme under-representation in the faunal sample).

All long bones were processed for marrow at PgPw-3, except those which belonged to very young calves. Marrow extraction to this extent is somewhat surprising assuming that spring killed muskoxen were probably in relatively poor nutritional condition when compared to other seasons. Bones with low marrow utility were not discarded even when the return of marrow was small. Grease manufacture may have been limited to bones possessing high grease value, if its quality is also a function of animal health. This argument suggested that the relationship between the archaeological MGUM and the %MNI of Nasogaluak anatomical parts would be characterized by an over-representation of elements with low grease utility, and an under representation of parts with high grease value.

The actual relationship is graphically represented in Figure 6.7. Elements which are more frequent than expected are the distal portions of the humerus, femur, tibia and metapodial, and the proximal half of the radius. Their

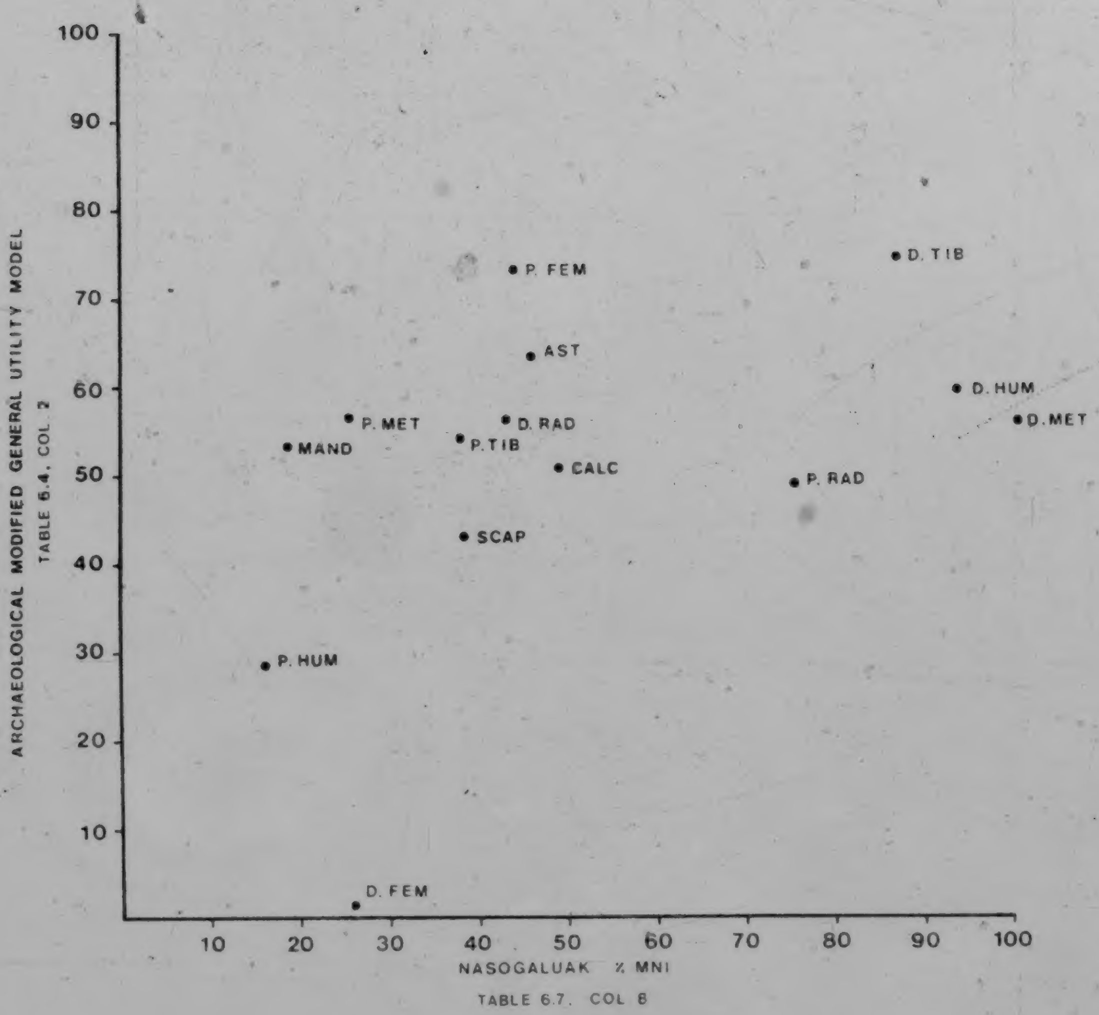


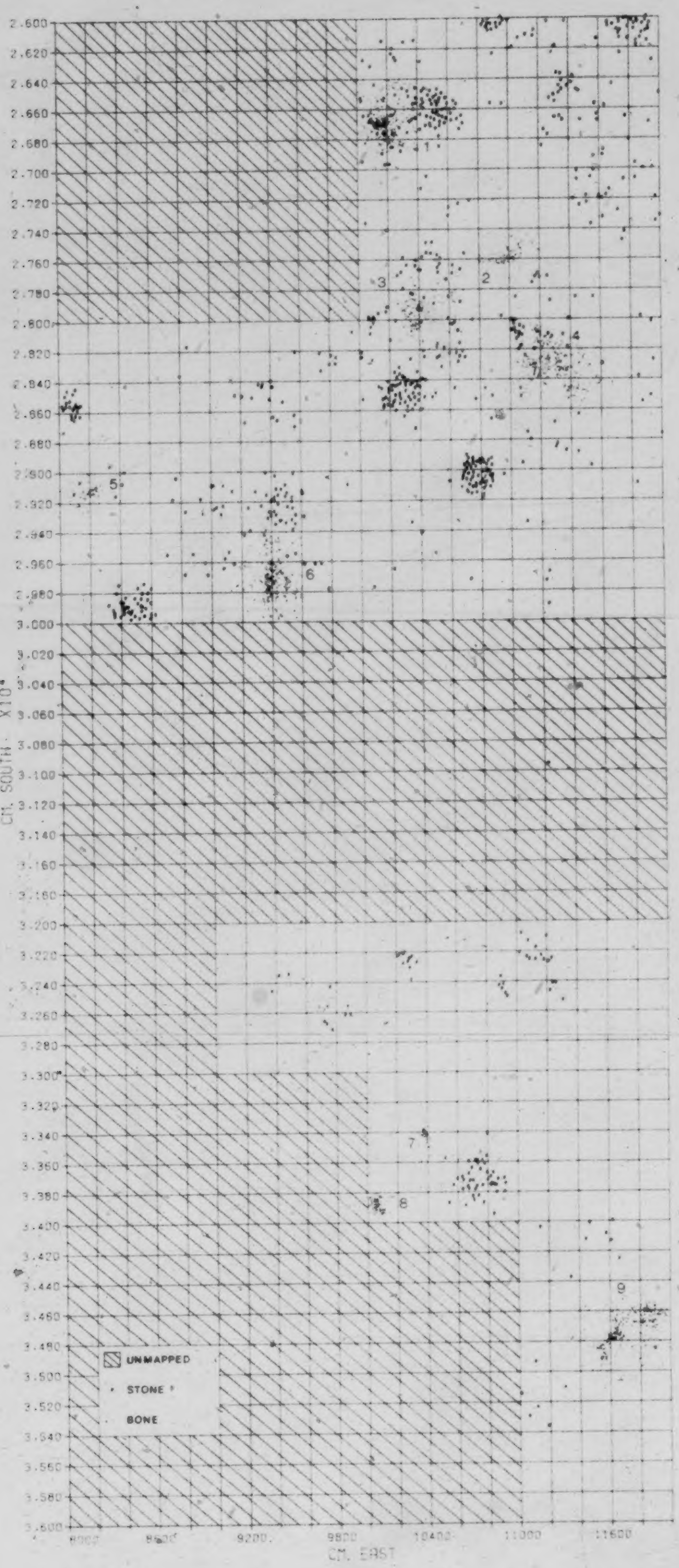
Figure 6.7 Relationship between the archaeological muskox general utility model and the %MNI from the Nasogaluak muskox assemblage.

variable grease content does not provide support for the hypothesis.

The fact that it is difficult to reconstruct a general subsistence picture for the Nasogaluak assemblage with the food use models may indicate that many decisions were involved in food processing and consumption in activity areas. This site was probably used during more than one season, and the large number of huge vaulted caches (presumably for food storage) suggests that food processing may have been greatly influenced by decisions regarding future utility. Intrasite use is described and discussed below.

Intrasite analysis

Nine activity areas were also delimited on the Nasogaluak site, and their distribution and proximity to stone features is depicted in Figure 6.8. Variation in bone concentration and size of activity area was greater than present at the Haogak site (see Table 6.9). The size of concentrations varied between 4 and 30 square meters. A low density of 4.0 bones/m^2 and a high of 30.2 bones/m^2 were calculated for the osteological assemblages. However, variation in bone density may actually not be as great due to the artifact of the grid system and the placement of arbitrary coordinates. Features were associated with five of the activity areas. Caches were present very near areas 1, 4, 6, and 7. Area 3 was associated with a possible tent ring. Anatomical part counts, MNI and %MNI are provided for


2.600
2.620
2.640
2.660
2.680
2.700
2.720
2.740
2.760
2.780
2.800
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2.860
2.880
2.900
2.920
2.940
2.960
2.980
3.000
3.020
3.040
3.060
3.080
3.100
3.120
3.140
3.160
3.180
3.200
3.220
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3.420
3.440
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3.480
3.500
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9800
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CM. EAST
1
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UNMAPPED
STONE
BONE

Figure 6.8 Distribution of bone concentrations and stone features on the Nasogaluak site.

Table 6.9

Summary Characteristics of Nasogaluak Activity Areas

Activity Area	Xmin	Xmax	Ymin	Ymax	Assoc. features	Area	No. of bones	Bone density/ square meter
1	100	104	264	269	large cache	20	413	20.6
2	108	112	274	278	none	16	102	6.3
3	102	107	277	282	possible tentring	25	233	9.3
4	110	116	280	286	cache	36	367	10.2
5	081	083	290	293	none	4	74	18.5
6	092	096	293	300	large caches	28	470	16.8
7	102	106	332	336	large cache	16	64	4.0
8	100	102	338	340	none	4	121	30.2
9	114	120	345	350	none	30	408	13.6

each activity area in Table 6.10.

Large stone caches are the most striking characteristic of PgPw-3. They are the predominant stone features on the site, and many have bone concentrations immediately adjacent to them. Activity areas 1, 4, 6, and 7 are examples (refer to Figure 6.8). Unlike the situation at Haogak, meat drying may have been a prerequisite before meat caching. Natural refrigeration was much reduced during the spring and summer, and unless proper precautions were taken, meat would spoil quickly in the relatively warm weather. Anatomical parts not considered suitable for drying in the spring by Copper Inuit included the head, chine, shoulders and thighs (see Chapter Two).

Areas 1, 4, and 6 possessed numerous bones, as well as high bone densities (Table 6.9). All four concentrations contained a large proportion of long bone diaphyseal fragments. Comparison with anatomical part %MNI between activity areas associated with stone caches on the Haogak and Nasogaluak sites (Tables 6.6 and 6.10) shows that they are dissimilar. In other words, subsistence activities related to food caching were different between the two sites (assuming contemporaneity, or a relationship of some sort, between the caches and activity areas). Therefore, in addition to examining the relationship between the meat, marrow and combined meat+marrow models, the relationship with the other utility models was also examined.

Table 6.10

Anatomical Part Counts from Nasogaluak Activity Areas

Anatomical part	No.	(1) MNI	%MNI	No.	(2) MNI	%MNI	No.	(3) MNI	%MNI
skull	0	0	0	2	2.00	100.00	0	0	0
mandible	0	0	0	1	.50	25.00	0	0	0
cervical	0	0	0	0	0	0	0	0	0
thoracic	0	0	0	7	.54	27.00	0	0	0
lumbar	0	0	0	3	.60	30.00	4	.08	18.82
pelvis	0	0	0	0	0	0	0	0	0
scapula	1	.50	8.33	1	.50	25.00	0	0	0
proximal humerus	4	2.00	33.33	0	0	0	0	0	0
distal humerus	12	6.00	100.00	2	1.00	50.00	7	3.50	82.35
proximal radius	8	4.00	66.67	1	.50	25.00	2	1.00	23.53
distal radius	4	2.00	33.33	1	.50	25.00	3	1.50	35.29
proximal femur	6	3.00	50.00	3	1.50	75.00	2	1.00	23.53
distal femur	4	2.00	33.33	1	.50	25.00	1	.50	11.76
proximal tibia	1	.50	8.33	0	0	0	0	0	0
distal tibia	10	5.00	83.33	2	1.00	50.00	3	1.50	35.29
proximal metapodial	6	1.50	25.00	7	1.75	87.50	6	1.50	35.29
distal metapodial	20	5.00	83.33	5	1.25	62.50	17	4.25	100.00
astragulus	10	5.00	83.33	3	1.50	75.00	4	2.00	47.06
calcaneus	7	3.50	58.33	1	.50	25.00	3	1.50	35.29
long bone frag	244			27			134		

Table 6.10 Continued

Anatomical Part Counts from Nasogaluak Activity Areas

Anatomical part	No.	(4) MNI	%MNI	No.	(5) MNI	%MNI	No.	(6) MNI	%MNI
skull	0	0	0	0	0	0	0	0	0
mandible	2	1.00	11.76	0	0	0	1	.50	6.67
cervical	0	0	0	0	0	0	0	0	0
thoracic	2	.15	1.76	1	.08	8.00	1	.08	1.07
lumbar	0	0	0	1	.20	20.00	1	.20	2.67
pelvis	0	0	0	0	0	0	0	0	0
scapula	5	2.50	29.41	1	.50	50.00	3	1.50	20.00
proximal humerus	1	.50	5.88	2	1.00	100.00	0	0	0
distal humerus	3	1.50	17.65	0	0	0	8	4.00	53.33
proximal radius	3	1.50	17.65	1	.50	50.00	7	3.50	46.67
distal radius	3	1.50	17.65	0	0	0	2	1.00	13.33
proximal femur	3	1.50	17.65	1	.50	50.00	8	4.00	53.33
distal femur	1	.50	5.88	1	.50	50.00	0	0	0
proximal tibia	3	1.50	17.65	0	0	0	8	4.00	53.33
distal tibia	17	8.50	100.00	0	0	0	15	7.50	100.00
proximal metapodial	4	1.00	11.76	1	.25	25.00	8	2.00	26.67
distal metapodial	18	4.50	52.94	0	0	0	28	7.00	93.33
astragulus	4	2.00	23.53	0	0	0	6	3.00	40.00
calcaneus	5	2.50	29.41	0	0	0	7	3.50	46.67
long bone frag.	255			49			273		

Table 6.10 Continued

Anatomical Part Counts from Nasogaluak Activity Areas

Anatomical part	No.	(7) MNI	%MNI	No.	(8) MNI	%MNI	No.	(9) MNI	%MNI
skull	0	0	0	0	0	0	0	0	0
mandible	0	0	0	4	2.00	80.00	2	1.00	23.53
cervical	0	0	0	0	0	0	0	0	0
thoracic	0	0	0	2	.15	6.00	0	0	0
lumbar	0	0	0	0	0	0	4	.80	18.82
pelvis	0	0	0	0	0	0	0	0	0
scapula	0	0	0	0	0	0	1	.50	11.76
proximal humerus	0	0	0	0	0	0	0	0	0
distal humerus	0	0	0	5	2.50	100.00	4	2.00	47.06
proximal radius	0	0	0	1	.50	20.00	3	1.50	35.29
distal radius	0	0	0	2	1.00	40.00	0	0	0
proximal femur	0	0	0	0	0	0	0	0	0
distal femur	0	0	0	1	.50	20.00	0	0	0
proximal tibia	0	0	0	0	0	0	0	0	0
distal tibia	0	0	0	2	1.00	40.00	4	2.00	47.06
proximal metapodial	1	.25	50.00	1	.25	10.00	0	0	0
distal metapodial	2	.50	100.00	6	1.50	60.00	17	4.25	100.00
astragulus	1	.50	100.00	2	1.00	40.00	2	1.00	23.53
calcaneus	1	.50	100.00	2	1.00	40.00	2	1.00	23.53
long bone frag.	49			52			101		

In area 4, no patterns were found with the meat or meat+marrow models. However, a relationship was produced with the marrow model which was similar to ones produced with the archaeological modified general utility and the marrow+grease models (for an example, see Figure 6.9). These relationships support the proposition that bones were selected from a larger assemblage and introduced into this location where they were processed for both marrow and grease. Bone processing could have been performed at the time of caching in which case meat was deboned, or at a later time when both dried meat and bone were removed from the cache for consumption. The fact that bones (scapulae and femora) from parts usually not dried in the spring (shoulder and thigh) were abundant indicates that a large number of anatomical parts were accumulated in area 4, with some being processed for immediate consumption, and others destined for future retrieval.

A remarkably similar set of relationships was generated between the %MNI of area 6 anatomical parts and the marrow, archaeological MGUM and marrow+grease models. The similarities between the two activity areas implies that they were used for identical purposes.

Both high and low food utility bones are present in area 1, and do not exhibit relationships with any of the food utility models. Distal portions of the humerus, tibia and metapodial are common in the assemblage by virtue of possessing anatomical part MNI of five or more. The hindleg

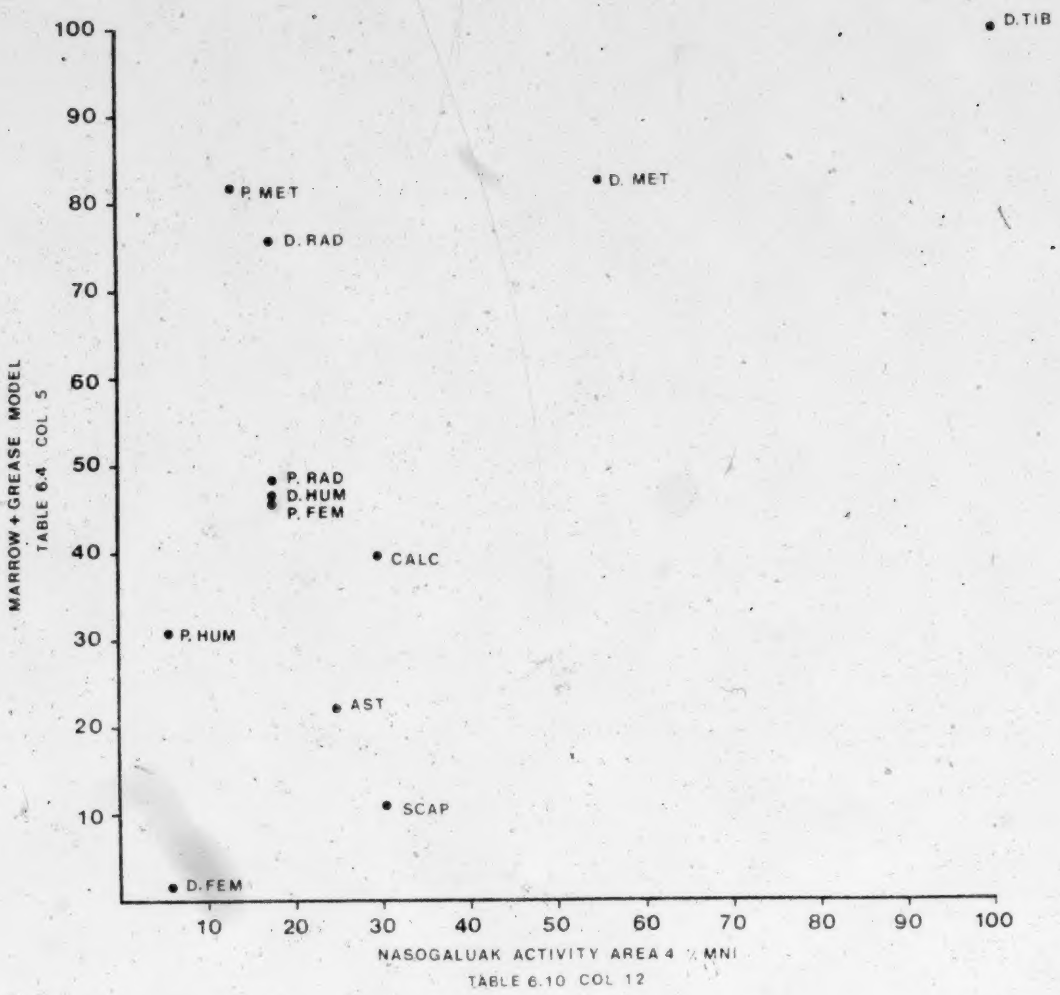

Figure 6.9 Relationship between the marrow+grease model and the %MNI from Nasogaluak activity area 4.

parts which are present possess the highest marrow values, whereas the distal humerus is most notable for the amount of meat on it. Conversely, the proximal portions of the humerus, tibia and metapodial occur in the smallest percentages among the limb elements. The first two have a high grease utility which could explain their absence; however, the proximal metapodial is low in grease but possesses a marrow value comparable to the distal portion. Femoral and radial bone portions are equally common and are characterized by considerable variability in their utility of all three foodstuffs. A total of 244 long bone diaphyseal fragments were counted in the area, supporting the proposition that marrow processing occurred there.

The models do not greatly aid in explaining the particular pattern of bone frequencies in this assemblage. Area 1 may have been used repeatedly for a variety of food processing activities such that the total osteological accumulation exhibits no relationship to the expected pattern diagnostic of any individual subsistence activity.

Activity area 7 is a small bone concentration containing only lower limb elements and 49 bone fragments (see Table 6.10). These bones possess the lowest values in the meat utility model. Aside from marrow utility, the metapodials possess little or no other food value. The astragalus and calcaneus were probably introduced as accessory elements. This area contains a subtractive assemblage, and probably did not have a functional association with the stone cache present nearby.

A possible tent ring occurs in association with area 3. The feature is less than two meters in diameter and is located in the north-central portion of the mapped area (see Figure 6.8). Examination of Table 6.10 shows that all appendicular parts except the scapula, proximal humerus and proximal tibia are present in the bone concentration. Long bone fragments are abundant implying that bones may have been processed for marrow in the area. The relationships between the meat, marrow, and meat+marrow models, and the %MNI of anatomical parts tabulated in area 3 were examined. No patterning was generated with any of the models, except for meat use, a situation which is similar to tent ring-associated bone concentrations 3 and 8 on the Haogak site. However, unlike the PhPo-3 areas, Nasogaluak area 3 is not notable for the absence of specific skeletal portions.

The relationship which does exist with the meat model strongly resembles the one attributed to discard areas - anatomical parts with high meat utility are under-represented, whereas parts with low utility are common or even abundant. Both high and low valued marrow bones are present. No activity other than discard of unwanted parts seems to account for the high frequencies of particular bone elements in this assemblage. Aside from proximity, no further evidence exists to attribute any relationship between this bone concentration and the nearby tent ring.

Four bone concentrations (nos. 2, 5, 8, and 9) were not affiliated with stone features. Based on experience with the Haogak activity areas, it was initially hypothesized that these concentrations were dumping areas of discarded parts. The relationship of each area with all seven utility models was examined.

Anatomical part %MNI in area 2 showed a relationship with the archaeological modified general utility model in that the frequency of various bones in this concentration conforms to that expected in a food processing rather than a discard location. An inconsistency with this interpretation is the unaccountably low number of long bone diaphyseal fragments (27) which are present.

In contrast to area 2, a negative relationship appeared between the %MNI of anatomical parts in area 5 and the archaeological modified general utility model. The majority of parts in this area are most notable for their meat value (cervical and thoracic vertebra, scapula, and proximal and distal femur). Bone portions which are not present are those which possess relatively high marrow and grease utility (distal humerus, distal radius, proximal and distal tibia and distal metapodial). The proportionally high number of long bone diaphyseal fragments suggests that marrow processing may have gone on in this area, but that some bone portions were taken elsewhere for grease processing.

The densest concentration of bone is 30.2 bones/m^2, and it occurs in activity area 8. It possesses the characteristics of a dumping area in that bones high in value for any or all three foodstuffs are not common in it. Additionally, the proportionally low number of long bone fragments indicates that processing for marrow did not occur in area 8.

Area 9 is characterized by a proportionally high number of long bone fragments, but bones with relatively high meat or grease value (proximal metapodial, proximal tibia, proximal and distal femur and distal radius) are not present. Marrow processing may have taken place here, but in general the %MNI of appendicular parts is similar to the pattern inferred for discard areas.

In summary, muskoxen were hunted in the region surrounding Nasogaluak during spring and summer. The occurence of numerous, large stone caches suggests that food consumption did not necessarily correspond with the season of procurement. Additionally, axial carcass portions were usually processed at kill-sites, and their bones were not transported to Nasogaluak. A strong non-linear relationship is exhibited between the archaeological MGUM and the %MNI of PgPw-3 anatomical parts.

Intrasite variation in carcass processing is considerable on this site. Bone concentrations in association with caches show positive relationships with the archaeological MGUM, marrow and marrow+grease models. Meat may have been deboned and then dried before placement into caches. Fats, especially those derived from marrow and bone grease, may have been immediately consumed in the spring when other sources of this nutritional requirement were unavailable. The Copper Inuit processed marrow from all muskox long bones in the spring even though animals may have had low fat reserves, because they were the only source of fats available.

Other areas on the site show strong resemblances to discard areas like those on Haogak. The bone concentration proximate to the possible tent ring (area 3) has characteristics unlike those of activity areas close to tent rings on PhPo-3. The %MNI of bone elements in it are diagnostic of a generalized dumping area.

The Nasogaluak site may have served as a temporary camp for people en route to and from Mercy Bay. It is ideally situated along the Thomsen River which provides a natural thoroughfare into the northeast portion of Banks Island. A substantial quantity of meat may have been cached at Nasogaluak for consumption in the fall on the way back from the Investigator cache. Some of the food resources may also have been processed and taken along on the trip down the Thomsen River.

Kuptana site analyses

Procurement

The Kuptana site (PjRa-18) is located in an environment which shares characteristics with the physical settings around the Haogak and Nasogaluak sites. The site is set high above the Thomsen River, and is separated from it by meadows that afford good muskox pasturage. Many of the muskox sightings around Kuptana were made in these meadows.

Muskoxen could have been driven in the direction of the site which is the closest nearby high ground. The crew crossed the meadows daily in order to reach Kuptana. On two occasions, muskoxen that were grazing in the meadows fled from our presence by galloping uphill and across the site area. If the animals went off in the opposite direction, they would have been blocked by the river. Hunters could have intercepted them there in the past. Muskox bones, spirally fractured, and at least one proximal radius with cut marks, were found in the sand dunes along the shore. Their age is unknown, however.

On the other hand, the meadows are quite large and parallel the river for several kilometers in both directions. Frightened animals could readily have fled upriver, rather than uphill in the direction of camp.

Dental annuli analysis indicates that PjRa-18 was used during spring, summer and fall (W. Kowal, pers. comm. 1983). Spring residence is also corroborated by the presence of muskox calf bones like those found on Nasogaluak. Considerable variation in muskox herd structure and behavior occurs during these three seasons (refer to Chapter Three). Animals would have been hunted individually, as well as in large herds. In addition, single sex and mixed sex muskox groups would have been present in the area for exploitation by Inuit camped at Kuptana.

Specific hunting strategies were suggested by the environments around Haogak and Nasogaluak, and the ratio of axial to appendicular parts in these sites substantiated them. The cumulative, archaeological results of multi-seasonal procurement at Kuptana was difficult to predict. It was reasoned that the axial to appendicular ratio would not resemble a kill-site/residence situation (1:1). Neither was it expected that the ratio would be as dissimilar as that found in an exclusively additive assemblage.

Counts of bone elements, whole animal MNI and anatomical part MNI for PjRa-18 are presented in Table 6.11. The ratio of 1:1.2 is obtained from whole animal counts of skulls and proximal radii. This result was somewhat surprising, because it indicated that most animals were dispatched very near or on the site. It is similar to the situation encountered at Haogak, and implies that much of the hunting may have taken place in late summer or early fall when large numbers of animals could have been driven into the site vicinity.

If the Kuptana hunters were procuring large muskox herds in late summer and fall, then the ratio of female to male animals should also be similar to the Haogak finding (1:1). The 257 skulls recorded in the intensively mapped portion of PjRa-18 included: 149 females, 95 males and 13 indeterminates (Table 6.11). The female to male ratio is 1.6

Table 6.11
Minimum Number of Individuals Count for the Mapped Portion of the Kuptana Site Muskox Assemblage

Anatomical Part	(1) Left	(2) Right	(3) Indet.	(4) Total	(5) Whole Animal MNI	(6) %	(7) Anatomical Part MNI	(8) %
skull				257	257	85.38	257.0	85.52
complete mandible	71	76	13	160	80	26.58	80.0	26.62
anterior fragment	133	120	47	300				
posterior fragment	114	102	3	219				
fragment	26	24	144	194				
cervical vertebra				951	136	45.18	135.9	45.22
thoracic vertebra				649	50	16.61	49.9	16.60
lumbar vertebra				350	70	23.26	70.0	23.29
indeterminate vertebra				1811				
complete pelvis	41	44	110	195	96		97.5	
incomplete pelvis	37	45	76	158	45	46.84	138.5	46.09
complete scapula	204	230	78	512	256		256.0	
glenoid fossa	18	15	11	44	23	92.69	22.0	92.51
blade fragment	20	13	121	154				
proximal humerus (fused)	60	56	23	139	70		69.5	
proximal humerus (unfused)	9	9	18	36	18	29.24	18.0	29.07
distal humerus (fused)	213	238	38	489	245		244.5	
distal humerus (unfused)	22	14	9	45	23	89.04	22.5	88.85
proximal radius (fused)	249	277	56	582	291		291.0	
proximal radius (unfused)	8	8	3	9	10	100.00	9.5	100.00
distal radius (fused)	124	157	35	316	159		158.0	
distal radius (unfused)	32	26	3	61	32	63.46	30.5	62.73
ulna	245	279	62	586	293	97.34	293.0	97.50
proximal femur (fused)	166	167	37	370	185		185.0	
proximal femur (unfused)	44	39	17	100	50	78.07	50.0	78.20
distal femur (fused)	121	122	27	270	135		135.0	
distal femur (unfused)	25	22	5	52	26	53.49	26.0	53.58
proximal tibia (fused)	159	200	40	399	200		199.5	
proximal tibia (unfused)	54	56	10	120	60	86.38	60.0	83.36
distal tibia (fused)	225	211	48	484	242		242.0	
distal tibia (unfused)	27	22	8	57	29	90.03	28.5	90.02
proximal metapodial				781	196	65.12	195.25	64.97
distal metapodial (fused)				994	249		248.5	
distal metapodial (unfused)				72	18	88.70	18.0	88.69
carpal				523	105		104.6	
tarsal				572	191		190.7	
astragulus	76	112	309	497	249	82.72	248.5	82.70
calcaneus	90	132	301	523	263	87.37	261.5	87.02
phalanx				1012	43		42.3	
rib or rib fragment				6242				
longbone fragment				2078				

to 1.

The presence of many more females than males is not necessarily surprising in the context of multi-seasonal hunting. This is because females with young may have been more likely to stand their ground and defend themselves than other animals. The long term result in the archaeological record would be a a higher female to male ratio. Young animals should also be common, however, they are not (see below).

Another explanation to account for the abundance of female muskox remains is that the Inuit may have managed the local muskox population by employing sex specific harvesting practices. It has been documented on Nunivak Island, Alaska (T. Smith 1983), and Ellesmere Island, N.W.T. (Freeman 1984) that when trophy hunting selectively reduces the adult, male muskox population, rapid declines in the general population follow. The elimination of adult, male animals in the defense of females and young may explain such population declines. Consequently, Copper Inuit who used the Kuptana site may have been aware of the importance of male muskoxen to maintaing healthy animal populations. If female muskoxen were killed more often due to this knowledge, the cumulative effects in the archaeological record would be a disproportionally high number of female skeletons. Further discussion of hunter-gather resource management appears in Chapter Seven.

Data for calculating the Kuptana maturity index are displayed in Table 6.12. Only the 1981 and 1982 information was used in the calculation, because long bone age was not an important data collection category in 1980. An index of 14.1 was derived from the long bone assemblage, and it is the highest score of all three sites. Unfused proximal radii were present on Kuptana. They were not abundant, but did constitute six percent of the whole animal MNI of that bone portion. Consequently, the MATI was recalculated without unfused, proximal radii so that it could be compared with the other site maturity indices. The revised statistic is 14.5 for that portion of the muskox assemblage containing animals with at least one long bone epiphysis fused. The average age of muskoxen in the Kuptana faunal sample is older than at either of the other sites. It cannot be determined whether a purposeful harvest of older animals was practiced, or if the average age of animals in the local population was greater than elsewhere.

Another hypothesis to explain this result has been offered by Hickey (pers. comm. 1984). Given that Kuptana may have been occupied for a longer period of time than the other sites, the higher MATI may reflect an 'aging' muskox population. The reasons for an average older population could have included natural causes, such as environmental stress, or human activity such as hunting pressure.

Table 6.12

Calculation of the Maturity Index (MATI) for the Kuptana Site

Value	Prox. Humerus		Dist. Humerus		Prox. Radius		Dist. Radius		Prox. Femur		Dist. Femur		Prox. Tibia		Dist. Tibia		Total
	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	%
open(1)	18	28.1	22	14.3	9	6.0	31	27.2	47	35.6	26	23.2	58	40.3	28	17.6	192.3
closed(2)	46	71.9	132	85.7	141	94.0	83	72.8	85	64.4	86	76.8	86	59.7	131	82.4	1215.4[1]

Total % = 1407.7

Maturity Index = 14.1

[1] percent total multiplied by closed value (2)

Use

The hypothesized procurement strategy indicates that the Kuptana assemblage contains both additive and subtractive characteristics. Processing of a large number of whole carcasses is suggested by the presence of 257 skulls in the mapped portion of this site. The vertebrae whole animal MNI are considerably less than the skull count, but this is in part due to the great number of vertebrae which were not discriminated into types in the field. Articulated vertebral columns occurred on the northern and mapped southern portions of Kuptana. In addition, long bones were processed for marrow with only a few exceptions. It was hypothesized that grease was also processed as it was at the other sites.

The %MNI of Kuptana anatomical parts (Table 6.11) were expected to show a positive relationships with the archaeological MGUM based on these factors. The actual relationship is depicted in Figure 6.10. It shows that the majority of bones are much more abundant than was anticipated by the model. Exceptions to this observation are elements in the vertebral column which have already been discussed. The anatomical part %MNI were also compared against the grease model, and no relationship was generated. In fact, no patterning was produced with any of the models. The only observation is that bones occur more frequently at PjRa-18 than is predicted by any of the models.

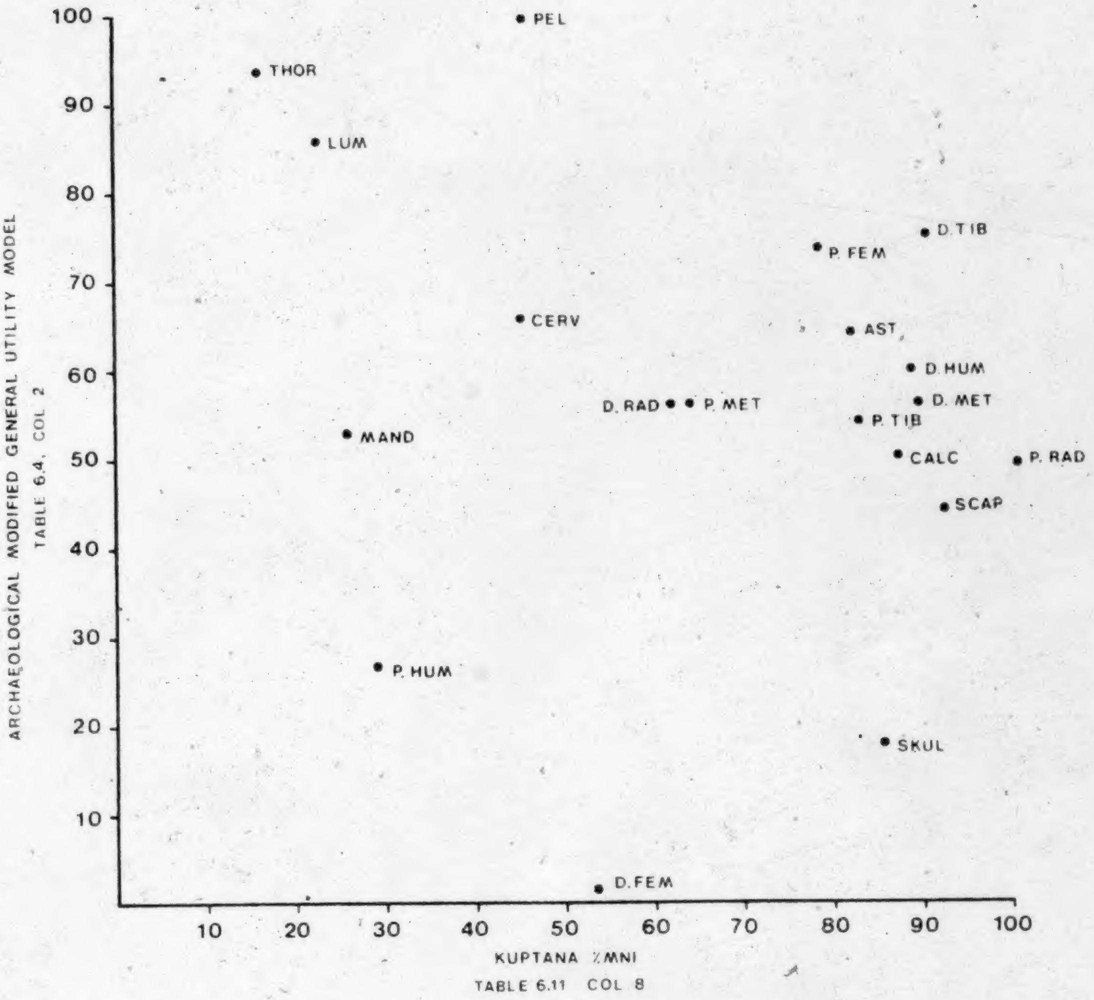

Figure 6.10 Relationship between the archaeological muskox general utility model and the %MNI from the Kuptana muskox assemblage.

There are at least two factors which contributed to the lack of correspondence between the maximization models and the site anatomical part %MNI. First, a large number of animals were processed on the site, and they contributed all of their bones to the assemblage. Decisions did not have to made by the Inuit regarding what parts of these carcasses should be transported to camp. Second, the range of variability among the %MNI is less than at other sites. Long bone %MNI are also quite high, and these two observations support the proposition that grease production was not an important activity at Kuptana. Therefore, models which incorporate grease extraction as a variable will not correlate with %MNI of anatomical parts from this site. However, processing for grease and other foodstuffs may have taken place in particular activity areas, and this possibility is considered below.

Intrasite analysis

Ten bone concentrations were chosen for analysis. They are widely distributed across the site (refer to Figure 6.11). Data on their location, associated stone features, size, number of bones present, and bone density are shown in Table 6.13. The areas varied in size from 8 to 20 m^2. The range in bone density among the concentrations was similar to that on the Haogak site. It was between 7.2 and 20.3 bones/m^2. However, this may be due to the method in which the areas were delineated with the computer program rather than to actual similarities in activities between sites.

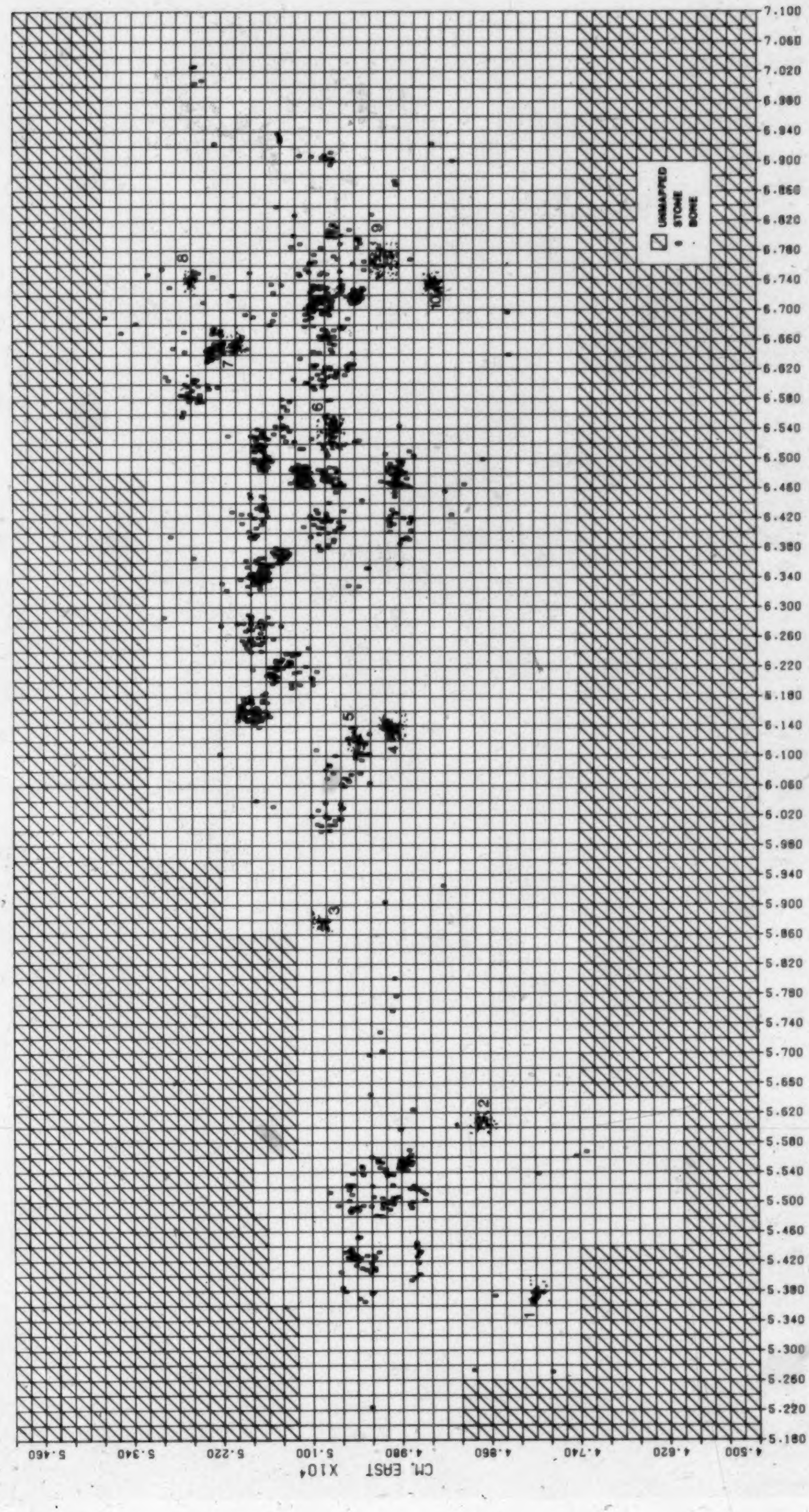
UNMAPPED
STONE
BONE
CM. NORTH X10⁴
CM. EAST X10⁴
5.180
7.100
4.500
4.620
4.740
4.860
4.980
5.100
5.220
5.340
5.460
1
2
3
4
5
6
7
8
9
10

Figure 6.11 Distribution of bone concentrations and stone features on the Kuptana site.

Table 6.13

Summary Characteristics of Kuptana Activity Areas

Activity Area	Xmin	Xmax	Ymin	Ymax	Assoc. features	Area	No. of bones	Bone density/ square meter
1	478	481	536	540	none	12	174	14.5
2	485	489	559	562	none	12	124	12.0
3	507	510	586	589	none	9	117	13.0
4	497	501	612	616	none	16	302	18.9
5	502	505	610	614	tentring	12	209	17.4
6	505	509	651	656	tentring	20	406	20.3
7	518	522	664	668	tentring	16	116	7.2
8	525	527	672	676	none	8	106	13.2
9	498	502	674	679	tentring	20	261	13.0
10	492	495	672	675	none	9	177	19.7

The activity areas are divided into two groups: those associated with tent rings (nos. 5,6,7 and 9), and those with no structural affiliation (nos. 1-4,8 and 10). It should be recalled that over 120 large, vault caches were observed on this site. They are grouped at both site ends (outside of the mapped area in Figure 6.11), and no bones were near any of them. The absence of faunal materials around these caches contrasts markedly with the situation at Nasogaluak.

Activity areas not proximate to features were analyzed like those found on the other two sites. All seven food maximization models were compared with the %MNI of anatomical parts from each location. Some of the relationships between the models and areas were expected to exhibit characteristics of discard areas. Bones which were low in food utility would be abundant, whereas high food utility parts would be scarce.

The %MNI of anatomical parts from area 1, situated at the northwest end of the intensively mapped portion of PjRa-18, produced strong linear relationships with the marrow (r=.73, p=.05) and marrow+grease (r=.84, p=.05) models (see Figure 6.12). These correlations support the contention that bones in this area were collected and processed for marrow and grease as predicted by the models. Interestingly, very few long bone fragments (23) were tabulated in this area. In fact, long bone diaphyseal fragments are rare to absent in all of the areas (see Table

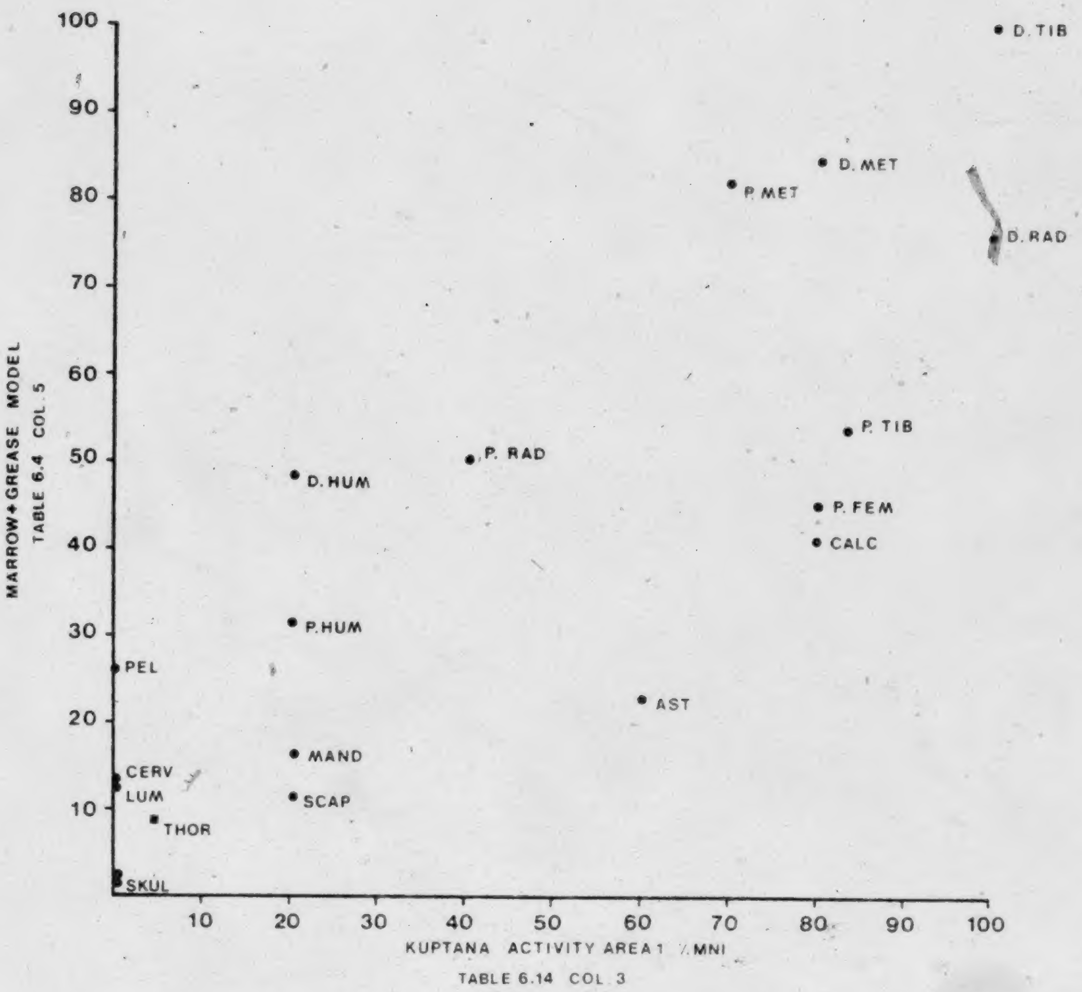

Figure 6.12 Relationship between the marrow+grease model and the %MNI from Kuptana activity area 1.

6.14). Vegetational cover, which is greatest on this site, may have biased their observability.

At the opposite end of this portion of the site, Area 10 exhibited close similarities to area 1 with respect to marrow and marrow+grease use. Area 10 is well away from the main concentration of tent rings as is area 1. This observation suggests that some types of subsistence activities were not necessarily performed near stone features. The zooarchaeological implication is that studies which use features, such as house structures, as the exclusive unit of analysis may be severely limited in their interpretation of animal use.

Area 2 lies to the south of bone concentration 1. The %MNI of anatomical parts from it show a relationship with the meat model. This area may have been a location where carcass parts were stripped of meat in preparation for drying and caching.

The %MNI of anatomical parts in area 3 show relationships with the marrow and meat+grease models which are similar to that depicted in Figure 6.9. This is also the situation with the %MNI of anatomical parts from Area 4 and the marrow model. Both areas are centrally located.

The last bone concentration which is not immediately proximate to a stone feature is area 8. It is located in the southeast part of the site (see Figure 6.11). Parts low in food utility are more common than predicted by the models, and the opposite is also true. This area is interpreted to

Table 6.14

Anatomical Part Counts from Kuptana Activity Areas

Anatomical part	(1) No.	(1) MNI	(1) %MNI	(2) No.	(2) MNI	(2) %MNI	(3) No.	(3) MNI	(3) %MNI
skull	0	0	0	0	0	0	0	0	0
mandible	1	.50	20.00	1	.50	20.00	0	0	0
cervical	0	0	0	4	.57	23.00	0	0	0
thoracic	1	.08	3.20	7	.54	22.00	0	0	0
lumbar	0	0	0	10	2.00	80.00	0	0	0
pelvis	0	0	0	3	1.50	60.00	0	0	0
scapula	1	.50	20.00	5	2.50	100.00	1	.50	14.29
proximal humerus	1	.50	20.00	2	1.00	40.00	2	1.00	28.57
distal humerus	1	.50	20.00	5	2.50	100.00	2	1.00	28.57
proximal radius	2	1.00	40.00	4	2.00	80.00	2	1.00	28.57
distal radius	5	2.50	100.00	1	.50	20.00	3	1.50	42.86
proximal femur	4	2.00	80.00	3	1.50	60.00	7	3.50	100.00
distal femur	0	0	0	3	1.50	60.00	1	.50	14.29
proximal tibia	4	2.00	80.00	0	0	0	7	3.50	100.00
distal tibia	5	2.50	100.00	2	1.00	40.00	5	2.50	71.43
proximal metapodial	7	1.75	70.00	2	.50	20.00	7	1.75	50.00
distal metapodial	8	2.00	80.00	0	0	0	3	.75	21.43
astragulus	3	1.50	60.00	1	.50	20.00	5	2.50	71.43
calcaneus	4	2.00	80.00	1	.50	20.00	7	3.50	100.00
long bone frag.	23			14			0		

Table 6.14 Continued

Anatomical Part Counts from Kuptana Activity Areas

Anatomical part	No.	(4) MNI	%MNI	No.	(5) MNI	%MNI	No.	(6) MNI	%MNI
skull	2	2.00	80.00	1	1.00	23.64	2	2.00	20.00
mandible	0	0	0	0	0	0	0	0	0
cervical	6	.86	34.40	31	4.23	100.00	40	5.70	57.00
thoracic	1	.08	3.20	0	0	0	1	.08	.80
lumbar	3	.60	24.00	0	0	0	0	0	0
pelvis	1	.50	20.00	0	0	0	2	1.00	10.00
scapula	1	.50	20.00	1	.50	11.80	18	9.00	90.00
proximal humerus	0	0	0	0	0	0	1	.50	5.00
distal humerus	3	1.50	60.00	0	0	0	6	3.00	30.00
proximal radius	4	2.00	80.00	1	.50	11.80	13	6.50	65.00
distal radius	4	2.00	80.00	0	0	0	1	.50	5.00
proximal femur	3	1.50	60.00	0	0	0	3	1.50	15.00
distal femur	5	2.50	100.00	1	.50	11.80	3	1.50	15.00
proximal tibia	3	1.50	60.00	0	0	0	3	1.50	15.00
distal tibia	4	2.00	80.00	0	0	0	11	5.50	55.00
proximal metapodial	5	1.25	50.00	1	.25	5.91	22	5.50	55.00
distal metapodial	3	.75	30.00	0	0	0	17	4.25	42.50
astragulus	3	1.50	60.00	1	.50	11.80	20	10.00	100.00
calcaneus	2	1.00	40.00	0	0	0	17	8.50	85.00
long bone frag.	7			0			0		

Table 6.14 Continued

Anatomical Part Counts from Kuptana Activity Areas

Anatomical part	No.	(7) MNI	%MNI	No.	(8) MNI	%MNI	No.	(9) MNI	%MNI	No.	(10) MNI	%MNI
skull	1	1.00	26.95	0	0	0	3	3.00	51.28	0	0	0
mandible	0	0	0	1	.50	12.50	0	0	0	2	1.00	13.79
cervical	26	3.71	100.00	5	.71	17.75	41	5.85	100.00	4	.57	7.86
thoracic	0	0	0	0	0	0	1	.08	1.37	7	.54	7.45
lumbar	0	0	0	0	0	0	0	0	0	3	.60	8.28
pelvis	0	0	0	2	1.00	25.00	1	.50	8.54	2	1.00	13.79
scapula	6	3.00	80.86	8	4.00	100.00	7	3.50	59.83	3	1.50	20.69
proximal humerus	0	0	0	1	.50	12.50	0	0	0	8	4.00	55.17
distal humerus	3	1.50	40.43	6	3.00	75.00	4	2.00	34.19	12	6.00	82.76
proximal radius	1	.50	13.48	3	1.50	37.50	2	1.00	17.09	5	2.50	34.48
distal radius	0	0	0	2	1.00	25.00	2	1.00	17.09	4	2.00	27.59
proximal femur	0	0	0	2	1.00	25.00	1	.50	8.54	8	4.00	55.17
distal femur	0	0	0	4	2.00	50.00	2	1.00	17.09	5	2.50	34.48
proximal tibia	0	0	0	4	2.00	50.00	2	1.00	17.09	13	6.50	89.66
distal tibia	0	0	0	1	.50	12.50	9	4.50	76.92	14	7.00	96.55
proximal metapodial	5	1.25	33.69	5	1.25	31.25	15	3.75	64.10	2	.50	6.90
distal metapodial	7	1.75	47.17	1	.25	6.25	2	.50	8.54	29	7.25	100.00
astragulus	3	1.50	40.43	3	1.50	37.50	6	3.00	51.28	4	2.00	27.59
calcaneus	2	1.00	26.95	5	2.50	62.50	1	.50	8.54	1	.50	6.90
long bone frag.	0			0			0			11		

be a dump.

The possible archaeological consequences of food sharing with respect to the analysis of muskox remains found near tent rings has been discussed for the Haogak site. Therefore, it should come as no surprise that no relationships were produced between the models based on food value and areas 5, 6, 7 and 9. All of the areas contained a diverse selection of carcass parts, except for area 7 which was strongly biased in favor of axial portions, upper front legs and lower legs.

Bone concentrations 5, 6, and 7 actually possessed %MNI characteristic of dumping areas. Their affiliation with tent rings may have been spurious, because they may have been deposited after the tent rings had fallen into disuse. The inconclusiveness of the interpretation points to the pitfalls of not being able to demonstrate functional contemporaneity between the bone concentrations and stone features. It also serves as a caveat to investigators who assume functional contemporaneity, and then attempt to explain the faunal remains in that context.

In summary, Kuptana is a large, multi-seasonal site where portions of at least 301 muskoxen were used. The presence of so many large caches means that much of the meat taken from the animals was stored for future consumption. It is not known if meat was boned before caching; however, observation demonstrates that food was not processed in the vicinity of storage facilities as it was at Nasogaluak.

Variation in food processing activities occurs across this site. Although grease production was an important activity at both Haogak and Nasogaluak, the Inuit did very little of it at this site. Seasonal differences in site occupation do not explain this finding. If bones were cached along with meat, perhaps they lost their grease value during storage. Another possibility is that people simply did not bother with the laborious task of rendering grease from long bones, because a sufficient quantity of fat was available from muskox meat and marrow.

Kuptana is located in the upper drainage of the Thomsen River, about a three day walk from the Investigator cache. The site contains large quantities of Investigator materials, which suggests that it may have been a staging area to initiate forays to Mercy Bay (Hickey 1981). Subsistence activities may have focused on procuring and storing large amounts of food over a short time period. The majority of people's efforts were then spent on collecting useful items from the cache of British goods.

Discussion

Muskox procurement and use has been described for each site, and similarities and differences among Haogak, Nasogaluak and Kuptana have been noted. Analyses of site use were performed with food use models similar to those developed by Binford (1978) to study Nunamiut subsistence behavior. It has been shown that some aspects of muskox carcass use by Copper Inuit were accurately predicted with the models. This is particularly apparent in the production of grease. Decision-making regarding the use of other foodstuffs was probably much more complex as demonstrated by variation which existed between expected and observed %MNI of anatomical parts.

The food use models did provide explicit expectations for interpreting patterning in the faunal record. Analyses using them made it feasible to suggest hypotheses concerning the meaning of bone concentrations sampled on the sites. This is something that would not have been possible without having a baseline for comparison, and is a continuing problem in zooarchaeology.

VII. Bones and Beyond

Introduction

The discussion to this point has been directed at examination of muskox procurement and use by Copper Inuit in the 19th century. This has been achieved with the application of Binford's (1978) approach to the analysis zooarchaeological remains.

In this chapter, additional issues are addressed which include: the explanation of variability in faunal assemblages; hunter-gatherer resource management; and the hypothesized extinction of muskoxen by the Copper Inuit. Lastly, directions for future research which are suggested by the present investigation are mentioned.

Faunal patterning: cultural vs. functional behavior

Two contrasting philosophies exist concerning the meaning of faunal patterning which are similar to those surrounding the explanation of variability in Paleolithic stone tool assemblages (Binford and Binford 1966). The first advocates that faunal patterning reflects cultural differences in the use of wildlife resources. Yellen (1977:329) holds this perspective, although he cautions:

> ...defining archaeological cultures on this basis would, from a practical point of view, be a thankless and probably hopeless task. But there are some cases where the evidence from faunal analysis might throw a welcome additional light on already existing problems ...there are a number of instances

> in which it would be interesting to know if conclusions drawn on the basis of lithic analysis would be supported by possible faunal analysis.

Another advocate of this position is Noe-Nygaard (1977) who argues that it is possible to discriminate paleolithic cultures on the basis of variability in butchering and marrow fracturing patterns. The general belief is that people will make culturally diagnostic decisions regarding the use of wildlife foods which translate into recognizable patterns in the zooarchaeological record.

The other perspective is that situationally dependent human behavior, regardless of cultural background, is responsible for creating patterning in faunal assemblages. The most outspoken proponent of this position is Binford (1978:455):

> *...there is not the slightest support for the position that variability in relative frequencies of similar things at different places is necessarily referable to variability in culture*...all the documented variability in faunal assemblages is directly referable to functional variability...(italics in original).

This is also essentially the stand taken by Hill (1979) who says that disarticulation of animal carcasses by humans:

> ...may differ only slightly from that in circumstances where man has not been involved. It seems that the determining controls of the pattern are inherent in the anatomy of the dead animals itself and thus independent of the agents whereby it is realized.

Proponents of either position have not adequately substantiated their case. Those favoring the cultural uniqueness of faunal assemblages have neglected to provide cross-cultural examples showing which characteristics of assemblages are culturally diagnostic. Although Binford (1978) is arguing from an informed position in that he possesses a thoroughly documented case study of functional variability in resource use, he also neglects to make comparisons with other cultural groups. His research objectives were designed strictly to examine functional variability. Consequently, any other kind of variability present in the Nunamiut data may have been overlooked.

Explanation of patterning in the zooarchaeological record remains open to questioning. The examination of Copper Inuit exploitation of muskoxen on Banks Island shows that functional context played a role in the use of meat, marrow and bone grease. However, this study additionally indicates that social relations regarding food sharing needs further investigation, because this kind of patterning might have applicability to the study of culturally diagnostic behavior. Despite Binford's (1984) recent pronouncements about the problems with ethnoarchaeological research, social variability in food use among contemporary hunter-gatherers and its implications to archaeology are in need of study. Ethnoarchaeological investigations concerning the social utility of wildlife foods and the resultant patterning in zooarchaeological remains should be conducted among different peoples. Food sharing behavior among such groups as the Dene of the MacKenzie region of northern Canada, and the Inuit of Arctic Canada should be observed to determine whether or not culturally diagnostic food refuse patterns exist.

Resource management and muskox extinction on Banks Island

The notion that prehistoric hunter-gatherers did not manage wildlife resources is pervasive implicitly and explicitly in the literature. The disappearance of Late Pleistocene megafauna is one well known example of animal extinction being attributed to human predation (Martin 1979). The reasoning for this kind of argument seems to be that hunter-gatherers who possessed relatively simple technologies did not understand the ecology of species used for food. Consequently, people had no strategies of wildlife management so that animals were harvested indiscriminately until local resource depletion forced them to move on or adapt to alternative subsistence resources.

Management of animal resources and ecological sophistication is, however, being demonstrated among living hunter-gatherers. For example, Nelson (1982:217-218) says that the Koyukon Athapaskans living in northwestern interior Alaska:

> ...not only know in detail the spatial arrangement of resources but also their temporal dynamics. They have seen each place grow rich in one species and then another, become alternatively abundant and sterile. And they have watched the ebb and flow of each species throughout their subsistence range, over the long and short run. This knowledge has been extended further in time by the accounts of elders. Taken collectively, these observations yield a thorough and sophisticated portrayal of an environment and its dynamics.

Knowledge which the Koyukon possess about the distribution and abundance of wild resources is used in everyday, as well as in long term, subsistence planning. Nelson reports that it is incorporated into the ideology of the people, and he (1982:221) goes on to say that:

> Considerations of sustained yield influence the level or intensity of hunting, trapping, fishing and gathering activities. This is a pragmatic, empirically-based approach to conservation of natural resources. People attempt to maintain healthy populations of resource species by regulating or manipulating their harvest; they specifically avoid taking more animals or plants than they feel can be replaced naturally, or they adjust their activity to enhance the productivity of a species.

Paralleling Nelson's (1982) findings, Freeman (1984) shows that the Inuit also have a clear understanding of resource management which in the past has enabled them to harvest animal species without irreversible depletion. This task is accomplished with a qualitative assessment of animal populations which differs from the quantitive evaluation performed by wildlife biologists. Freeman (1984:17) writes that:

> The sum total of the community's empirically-based knowledge is awesome in breadth and detail (see eg. Freeman 1979), and often stands in marked contrast to the attenuated data available from scientific studies of these same populations.

In addition to managing wildlife resources, it has been documented that hunter-gatherers employ sound ecological reasoning to increase environmental productivity. One example is found in Lewis' (1977, 1982) research into the controlled use of fire by native people. In many parts of

Temperate and Boreal North America, and specifically in northern Alberta, Canada, people have traditionally burned meadows in the spring to encourage early plant growth which attracts game animals, such as moose (Lewis 1982:28).

Implicit in Stefansson's (1913; 1921) hypothesis about muskox extinction is the notion that people did not manage the animal resource. It can be argued that people visiting northern Banks Island for the first time would not have been familiar with local muskox distribution and abundance. In addition, Victoria Island Inuit had traditionally subsisted on caribou during summer and fall so that the biology and behavior of muskoxen may have been unknown to them.

Although the Kanghiryuarmiut may rarely have procured muskoxen, their neighbors on Bathurst Island hunted them and were aware that the animals were not a dependable food resource (Boas 1974). Even if the Copper Inuit possessed little direct experience with muskoxen, they may have had considerable folk knowledge of them. Freeman (1984:13) cites an example where Inuit from southern Ellesmere Island knew a lot about muskoxen although the animals:

> were not hunted by the Inuit for food or skins, nor did the presence of muskox in their hunting territory contribute in any material sense to their wellbeing. Furthermore, muskox were an "unknown" species (except for oral tradition in the case of a few hunters) until people moved to the region from ten to thirteen years earlier.

The information collected from the three Copper Inuit archaeological sites investigated in this study shows that people were cognisant of muskox behavior and biology.

Hunters knew where to locate animals, and how to procure them. The discussion of carcass use in the last chapter demonstrates that the people were thoroughly acquainted with animal anatomy. It may have been more than just coincidence that the exhaustion of local food supplies on Banks Island was timed with the last trips to Mercy Bay around 1895 (refer back to Chapter Two). Some form of muskox management may have been necessary to ensure that local, animal extinction did not occur while goods were being retrieved from the *Investigator* cache.

Stefansson's hypothesis has also been cited to explain the lack of muskox sightings on the island before 1950. Reported estimates of muskoxen in Banks Island archaeological sites have been used as evidence to corroborate the hypothesis. For example, Vincent and Gunn (1981:176) write:

> The Eskimos almost exterminated the muskox population by 1900 (Stefansson, 1921). Archaeological field studies in northern Banks Island in 1979 - 1980 have described 150 sites with 2700 muskox remains (C. Hickey, pers. comm. 1981).

No context exists for interpreting the significance of the archaeological estimate of harvested muskoxen, because: 1) the original muskox population size prior to 1855 is not known, so that sustained yield harvests cannot be calculated, and 2) no methods exist for determining how animal deaths were spaced over the 35 year period that the Copper Inuit procured animals.

If the Investigator cache were visited yearly between 1855 and 1890 by the same number of people, then the average annual number of animals killed was only 78, based on an MNI of 2,700 muskoxen found in the Banks Island Copper Inuit archaeological sites (Hickey, pers. comm. 1983). In 1982, a total of 96 muskoxen were commercially harvested on the island with the sanction of the N.W.T Wildlife Service (Anonymous 1982). The estimated total population at that time was about 10,000 animals (Latour, in Urquhart 1982:4).

The size of the island muskox population prior to the arrival of 19th century Inuit is not known. However, it has been noted in Chapter Three that Banks Island is a productive muskox habitat. Muskox fertility and calf survival are currently high without extensive interference through human predation. A similar situation may have existed in the pre 1855 period so that the island muskox population then would have been as large or greater than the contemporary one.

Given the size of recent muskox harvests, a harvest of 78 animals annually probably would not have resulted in extinction, especially if any management strategy were employed. However, Copper Inuit groups who visited Mercy Bay may have varied considerably in size from one year to the next so that variation in the annual number of animals could also have varied. If hunters dispatched only muskox in specific age groups, then there might have been significant biological consequences to local animal social groups. The archaeological data show to the contrary that animals of both sexes and different ages were harvested.

Wildlife information described previously (see Chapter Three) indicates that drastic declines in muskox populations have occurred in a single year when unfavorable fall and/or winter weather conditions prevented animals from obtaining adequate forage. If this situation happened during the late 19th century, then muskox herds available for spring, summer and fall hunting could have been substantially depleted. The absence of very young animals from the Haogak faunal assemblage lends support to this hypothesis. Huge annual variation in muskox numbers might have rendered resource management practices ineffectual. Human predation on remaining muskoxen in limited areas could have resulted in local animal extirpation. On the other hand, the demise of the animal population may have been entirely due to natural causes as was the case with Bathurst Island muskoxen in 1973-74. The archaeological data are too imprecise for concluding which factor, human or natural, played the most important role in the purported extirpation of Banks Island muskoxen.

Directions for Future Zooarchaeological Research

Like many investigations, this study provides insights into areas where further research is required, and suggests directions for improving on existing approaches. The necessity to continue to collect ethnoarchaeological information regarding the procurement and use of wild foods has already been mentioned. Observations, such as those by Jarvenpa and Brumbach (1983) on Athapaskan moose processing are valuable for demonstrating that a great amount of functional variabitity in hunter-gatherer animal use remains to be documented.

New perspectives are needed for collecting wildlife information used by zooarchaeologists. Faunal laboratories traditionally assemble comparative collections of animal skeletons in order to identify archaeological specimens. Emphasis is frequently placed primarily on obtaining osteological materials in good condition, rather than on acquiring detailed information about the animals who contributed the bones. Binford's (1978) work dramatizes the urgency for redirecting zooarchaeological efforts from bone identification to the measurement of wild animal food value. Osteological identification is an essential preliminary step in the investigation of archaeological faunal assemblages, but it is not the *raison d'etre* of zooarchaeology.

In order to attain this objective, much more emphasis needs to be placed on interdisciplinary research. A plea for integrating faunal analyses into the overall goals of archaeological projects has already been made by others (for example, see Bonnichsen and Sanger 1977). Obtaining precise information about animal anatomy and its potential food value to humans requires the expertise of specialists in wildlife and nutrition sciences. Interdisciplinary efforts to assess the quantity and quality of wild animal foods require consideration of differences between the sexes and among age groups, as well as seasonal variation in animal condition. An initial starting point for determining how food value should be measured in terms of human nutrition, and which kinds of food should be assessed, is by interview with people who continue to rely upon wild animals for subsistence. This is essentially the approach taken by Binford (1978) with respect to investigating Nunamiut use of caribou and sheep, and is the one being advocated here.

Summary

Aside from the presentation of culturally and historically interesting information on muskox procurement and use by Copper Inuit, several other contributions have resulted from this study. First, a specific theoretical orientation and explicit set of methods were employed in the analysis of faunal remains. This kind of approach is absolutely essential to zooarchaeology in order to generate: 1) appropriate data collection methods, 2) more realistic subsistence models (in terms of archaeological testability), and 3) middle-range theory concerning hunter-gatherer behavior.

Second, the meaning of faunal patterning in the archaeological record of animal use was briefly considered. The most important conclusion was that much more comparative research must be conducted among living hunter-gatherers before the functional and/or cultural distinctiveness of food refuse patterns can be confidently assessed.

Third, the idea that hunter-gatherers manage resources in their environment, and the hypothesis that muskoxen were extirpated on Banks Island by 19th century Copper Inuit were briefly examined. Recent evidence suggests that hunter-gatherers possess an enormous amount of synchronic and diachronic information about their environment which enables them to manage resources effectively.

Finally, and perhaps most important specifically to zooarchaeologists, is that this study suggested a number of avenues for future research. It is through particularistic and empirically rich studies like the present one that new research directions and contributions to theory and method in archaeology may be generated.

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